REVISED LONG-TERM GROUNDWATER MONITORING PLAN

AMERICAN CHEMICAL SERVICE, INC.
NPL SITE
GRIFFITH, INDIANA

MWH File No.: 2090603

Prepared For:

ACS RD/RA Executive Committee

Prepared By:

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September 2002

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Prepared by: ______________________________ September 20, 2002
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ACRONYMS AND ABBREVIATIONS

ACS	American Chemical Service, Inc.
BWES	Barrier Wall Extraction System
FSP	Field Sampling Plan
MWH	Montgomery Watson Harza
NPL	National Priorities List
ONCA	On-site Containment Area
OFCA	Off-site Containment Area
PCBs	Poly-chlorinated biphenyls
PGCS	Perimeter Groundwater Containment System
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RD/RA	Remedial Design/Remedial Action
SSP	Site Safety Plan
SVOCs	Semivolatile Organic Compounds
TCL/TAL	Target Compound List/Target Analyte List
µg/L	micrograms per liter
U.S. EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

A long-term groundwater monitoring program is required as part of the remedy for the American Chemical Service, Inc. (ACS) National Priority List (NPL) Site, in Griffith, Indiana. Groundwater monitoring has been conducted periodically since the remedial investigation in 1988. Monitoring wells have been added to the monitoring network during several groundwater investigations. The present groundwater monitoring network consists of 44 monitoring wells, 106 piezometers and 12 staff gages. Twenty-three monitoring wells are screened in the upper aquifer and 21 are screened in the lower aquifer.

The first four quarterly sampling events conducted in 1996 and 1997 were used to establish a baseline of groundwater quality and to document the groundwater flow system and hydraulic gradients in the upper and lower aquifers. An interim long-term groundwater monitoring plan (interim monitoring plan) was developed to define the required groundwater sampling necessary during the remedial design phase. This interim monitoring plan was submitted to the U.S. Environmental Protection Agency (U.S. EPA) and the Indiana Department of Environmental management (IDEM), and approved in 1998. Groundwater monitoring has been conducted quarterly under that plan since that time.

To date, five years of quarterly and semi-annual monitoring data have been collected from the ACS groundwater monitoring network under the approved plan, and these results provide a strong basis for developing an efficient long-term monitoring program for the Site. The purpose of this report is to present updated monitoring objectives and to outline a revised Groundwater Monitoring Plan (the Plan) which will be appropriate for the long-term monitoring of groundwater quality and evaluation of remedial measures carried out at the Site.

The Plan is to be used in conjunction with the U.S. EPA-approved Quality Assurance Project Plan (QAPP), the Field Sampling Plan (FSP), and the Site Safety Plan (SSP) Addendum. The QAPP, approved by the agencies on November 19, 2001, is a stand alone document and covers the groundwater monitoring program, effluent and off-gas sampling for the treatment plant and In-Situ Soil Vapor Extraction (ISVE) system, and the PCB-impacted soil confirmation sampling. The sampling protocols and health and safety issues for the groundwater monitoring activities are outlined in the FSP and SSP Addendum, which are included as Appendices in this document.

This report is presented in the following sections:

- Section 2 summarizes the components of the current groundwater monitoring plan and provides an evaluation of the findings from the past five years of monitoring;
- Section 3 describes the proposed revisions to the Plan; and
- Section 4 provides the references cited in the report.

2.0 EVALUATION OF THE CURRENT GROUNDWATER MONITORING PLAN

The Remedial Investigation (RI) was conducted at the ACS Site between 1988 and 1990. It consisted of three phases designed to identify source areas and map the extent of impacts to groundwater in the upper and lower aquifers. The Record of Decision (ROD) required additional investigations to map the extent of groundwater impact in both the upper and lower aquifers. Further groundwater investigations were conducted in accordance with the ROD and additional upper and lower aquifer monitoring wells were installed during 1996 and 1997.

These investigations were used to develop a more thorough understanding of the groundwater flow system and to determine the characteristics and the extent of impacts to the groundwater. The hydrogeologic setting and the groundwater monitoring results are summarized in the following sections.

2.1 HYDROGEOLOGY

2.1.1 Aquifer Characteristics

There are two aquifers of concern at the ACS Site: an upper water table aquifer and a lower confined aquifer. Both aquifers consist of fine to medium-grained sand with some silt and gravel. The aquifers are separated by a clay confining layer. The ground surface elevation at the Site ranges between 630 and 650 feet above mean sea level (amsl). Bedrock is located at an elevation of about 550 feet amsl. The two aquifers and the clay confining layer comprise the approximately 100 feet of alluvial material overlying the bedrock.

The water table in the upper aquifer ranges between 630 and 635 feet amsl. The top of the clay confining layer marks the base of the upper aquifer. It is located at approximately 620 feet amsl. Therefore the saturated thickness of the upper aquifer ranges between 10 and 15 feet.

The lower aquifer is confined beneath the clay layer. The top of the clay layer is generally found within a foot or two of the 620 foot elevation, so it is the bottom elevation of the clay layer that determines the overall thickness of the confining layer. In general the clay layer is thickest toward the south and east end of the Site. It is less than five feet thick northwest of the Site (near MW10C), and greater than 25 feet at the south end of the Site (near MW28). Borings at the perimeter of the ACS facility indicate that the clay confining layer could be ten or more feet thick beneath the ACS facility itself.

The regional groundwater flow in the upper aquifer is generally from east to west. At the ACS Site, the upper aquifer groundwater flow is diverted to the north and to the south by the barrier wall, installed in 1997 as part of the ACS final remedy. Groundwater flow in the lower aquifer is northward with an average hydraulic gradient of 0.0004 as measured over the past five years. There are strong downward vertical gradients from the upper aquifer to the lower aquifer across the clay confining layer. Gradient values range from less than 0.5 to greater than 1, depending upon the thickness of the clay layer.

2.1.2 Extent of Groundwater Impacts

Waste was buried at the Site in four general areas: the On-Site Containment Area (ONCA), the Off-Site Containment Area (OFCA), the Still Bottoms Area, and the Kapica-Pazmey Drum Recycling Area. The monitoring database from past investigations indicates upper aquifer impacts extend southeast from the OFCA and north and west from the active ACS facility. The only observed lower aquifer impacts appear to be related to faulty monitoring well construction at MW09, ATMW4D, and W-1. MW09 was replaced with MW09R in 1998, and ATMW4D and W-1 were abandoned and replaced with MW56 in 2001. Concentrations have since been observed to decrease at both locations.

Stabilization measures for the upper aquifer were completed in 1997. These include the construction of a 4,500 foot barrier wall with extraction system (BWES) and a perimeter groundwater containment system (PGCS). The barrier wall was keyed into the upper clay confining later, isolating the areas of buried waste on the inside. The PGCS is a 1,500-foot long groundwater collection trench, constructed to prevent further off-site migration of contaminated groundwater in the upper aquifer.

An interim monitoring plan was developed in 1998 to focus the monitoring program during the remedial design stage of the ACS Project. The following section provides a description and evaluation of this plan.

2.2 EVALUATION OF THE INTERIM MONITORING PLAN

2.2.1 Objectives

Eight Site-specific objectives were developed for groundwater monitoring activities during the remedial design and remedial action. Six of these objectives pertained to groundwater monitoring outside of the barrier wall, while two pertained to treatment plant influent and effluent sampling[1]. The groundwater monitoring objectives are listed below:

1) Collect water level data to monitor groundwater flow in the upper and lower aquifers and calculate the hydraulic gradients between the aquifers.

2) Collect water level data to document the performance of the PGCS and BWES and to evaluate changes in the groundwater flow system resulting from the remedial actions.

3) Collect and analyze groundwater samples from upgradient monitoring wells in the upper and lower aquifer to document background groundwater quality.

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[1] These two objectives are specifically applicable to the monitoring of the groundwater treatment plant (GWTP) at the Site and as such, they are addressed in the GWTP report, which is completed each quarter and submitted separately to the agencies.

4) Collect and analyze groundwater samples from the monitoring wells at the downgradient boundaries of the Site to closely monitor the status of the boundaries of groundwater impacts.

5) Collect and analyze groundwater samples from the interior of the areas of contaminated groundwater to document how concentrations change with time and in response to the remedial actions.

6) Assess progress toward attaining cleanup objectives in contaminated areas.

2.2.2 Components

The following components were included in the interim monitoring plan to meet the objectives outlined above:

- Water levels monitored every quarter at 67 wells, 106 piezometers, and 12 staff gauges, and this data used to develop groundwater elevation contour maps and calculate hydraulic gradients.

- Two major sampling events conducted annually at 44 monitoring wells in the groundwater monitoring network (23 upper aquifer and 21 lower aquifer monitoring wells).

- Samples from the 44 wells analyzed for full-scan Target Compound List/Target Analyte List (TCL/TAL) parameters during one of the major annual sampling events.

- Samples from the same 44 wells analyzed for indicator volatile organic compound (VOCs) and two metal analytes during the second of two major annual sampling events.

- Samples from three monitoring wells which showed concentration variability during the baseline sampling events analyzed for indicator compounds on a *quarterly basis*.

- Up to five residential wells near the ACS Site sampled annually for full-scan TCL/TAL parameters.

In the upper aquifer, groundwater sampling was focused on three impacted areas: North, West, and Southeast, each of which is downgradient of source areas defined within the ACS Site. In each area, certain wells were designated as upgradient, downgradient, and interior to the area of groundwater impacts. The purpose was to monitor the boundaries of the contaminant plume and provide early warning of any expanding contamination. Additionally, the interior wells were sampled to look for effects of the BWES and PGCS on contaminant cleanup.

Lower aquifer monitoring was conducted to document upgradient and downgradient water quality, and also to evaluate the groundwater quality trends in the MW09 area where impacted groundwater leaked from the upper aquifer to the lower aquifer along the well casing. More recently, MW56 has been installed to monitor the impacts of the apparent cross-aquifer migration at the northwest corner of the ACS Site at ATMW4D and W-1.

2.2.3 Findings

Seventeen rounds of quarterly groundwater monitoring have been conducted since late 1996. Rounds 1 through 4 were the baseline sampling events, conducted in 1996 and 1997. Rounds 5 through 17 were conducted under the interim monitoring plan. The 17th round of sampling was completed in June 2001.

Five years of results have confirmed consistency in the flow systems and water quality of the upper and lower aquifers:

- The groundwater flow directions and hydraulic gradients in and between the upper and lower aquifers remain similar from one season to the next and from one year to the next.

- The contaminants in groundwater are a relatively small suite of VOCs.

- Concentrations at a few wells exhibit variable results that are, for the most part, attributable to seasonal variations. These wells are located in the internal part of the plume.

- The extent and characteristics of the impacted groundwater zones appear to have stabilized.

These findings are described in more detail below:

2.2.3.1 Groundwater Flow

Since the completion of the barrier wall and PGCS in 1997, groundwater flow in the upper aquifer has been very consistent. Regional groundwater is generally from east to west in the vicinity, being diverted around the Site to the north and south by the barrier wall. To the north, groundwater flow is contained by the PGCS. The groundwater hydraulic gradient in the wetlands west of the Site is relatively flat. At the south end of the Site, the groundwater flow directions are to the south and southeast.

In the lower aquifer, groundwater flow has been consistently northward with an average horizontal gradient over the past five years of 0.0004 ft/ft. Measurements of the vertical hydraulic gradient in the lower aquifer have been low and directionally variable, and do not indicate a prevailing trend.

The vertical gradient calculated between the upper and lower aquifer indicates that a strong downward gradient exists between the aquifers across the Site. The average groundwater elevation in the upper aquifer is approximately 630 feet and the average groundwater elevation in the lower aquifer is approximately 620 feet. This ten foot drop in groundwater level occurs across the clay confining layer. It results in a downward gradient from less than 0.5 to more than 1, depending upon the thickness of the clay confining layer at the measured location.

2.2.3.2 Groundwater Contaminants

During the RI and in the investigations following it, groundwater samples were analyzed for a broad range of parameters including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides and poly-chlorinated biphenyls (PCBs), and inorganics.

A statistical summary of the detections of organic compounds in upper and lower monitoring wells is provided in Tables 1 and 2. These tabulations list the total number of samples collected and the number of times each compound has been detected since the initiation of the RI in 1988. The compounds are sorted by frequency of detection, and include the maximum and minimum detections for the compound. These analyses are summarized below:

Upper Aquifer (See Table 1)

VOCs

- Benzene was detected in 45% of the samples, and chloroethane was detected in 40% of the samples.

- Methylene chloride and acetone were detected in 20% and 17% of the samples, respectively. Sixty-six percent of these detections occurred during two of the 17 sampling rounds, rather than occurring consistently throughout all sampling rounds. During these two sampling rounds, these compounds were detected in field blanks, trip blanks, and method blanks, indicating that these detections were due to lab contamination. Detections of these compounds in other sampling rounds have also been the result of lab blank contamination. All detections of these compounds since 1998 have been below U.S. EPA cleanup levels.

- Several chlorinated hydrocarbons, such as trans-1,2-dichloroethene, 1,2-dichloroethane, and vinyl chloride, were detected in 15% or less of the samples. Many of these compounds were detected in samples where benzene and chloroethane were detected, but at concentrations below the detection limit (usually 10 μg/L).

- Chlorobenzene was detected in 10% of the samples; all of these detections were at two wells, MW12 and MW45.

- Xylenes and Ethylbenzene were detected in 8% and 6% of the samples, respectively; all of these detections were at wells MW06 and MW45, which are interior wells (inside the plume) located south of the Site. These compounds are possibly related to activities at the Town of Griffith municipal garage with its underground tanks and vehicle maintenance, which is also upgradient of these wells.

- Several compounds detected in 11% or less of the samples were detected below the detection limit (usually 10 µg/L) or in random assortments of wells, rather than at wells with detections of benzene and chloroethane.

SVOCs

- Phenols and bis(2-ethlhexyl)phthalate were detected in 32% and 16% of the samples, respectively. These compounds were detected in all Site wells, and were found to be related to the type of tubing used during initial sampling events rather than Site-related impacts. After this tubing was replaced, detection of these compounds was infrequent and usually below the detection limit.

- Bis(2-chloroethyl)ether was detected in 27% of the samples; the consistent detections were in wells M-4S, MW06, MW19, MW45, MW48, and MW49, all of which are interior to the contaminant plume.

- 2,2'oxybis(1-chloropropane) was detected in 12% of the samples; the consistent detections were in interior wells MW19, MW45, and MW49, and in upgradient well MW12.

- Several compounds detected in 10% or less of the samples were detected below the detection limit (between 10 µg/L and 30 µg/L) or in random wells, rather than at wells with detections of benzene and chloroethane.

PCBs

- There was only one detection of PCBs during the 17 rounds of sampling, indicating that PCBs are not compounds of concern in groundwater at the Site.

Pesticides

- Pesticide compounds were detected in less than 9% of the samples, and the detections did not correspond to wells with VOC contamination.

- Pesticides and herbicides are commonly used in the area, and are not related to Site activities.

Lower Aquifer (See Table 2)

VOCs

- Benzene was detected in 21% of the samples, and chloroethane was detected in 18% of the samples.

- Acetone and methylene chloride were detected in 16% and 15% of the samples, respectively. As mentioned above, these compounds were related to lab contamination and have been below U.S. EPA cleanup levels since 1998.

- All other compounds were detected in 6% or less of the samples; these compounds were often detected below the detection limit (usually 10 µg/L) or in a random assortment of wells, rather than at wells corresponding with detections of benzene and chloroethane. This low number of detections indicates that the detections were random.

SVOCs

- Phenol and bis(2-ethlhexyl)phthalate were detected in 41% and 31% of the samples, respectively. These compounds were detected in all wells, and were found to be related to the type of tubing used during initial sampling events rather than Site-related impacts. Since this tubing was replaced, detections of these compounds are infrequent and usually below the detection limit.

- Bis(2-chloroethyl)ether was detected in 9% of the samples; the consistent detections were in MW09 and its replacement well MW09R.

- Isophorone was detected in 8% of the samples; the consistent detections were in wells MW09/09R and MW53, and all detections were below the detection limit (usually 10 µg/L).

- All other compounds were detected in 2% or less of the samples.

PCBs

- There were no detections of PCBs in lower aquifer wells at the Site.

Pesticides

- Pesticide compounds were detected in less than 10% of the samples, and were almost always detected below the detection limit. Also, the detections did not correspond to wells with VOC contamination.

- Pesticides and herbicides are commonly used in the area, and are not related to Site activities.

These tabulations show that the characteristic organic contaminants for the Site are VOCs, and the most consistently detected VOCs are benzene and chloroethane. The results also show that SVOCs, PCBs, and pesticides have not migrated away from the source areas in the groundwater, and are not of concern or are not related to Site activities. Only bis(2-chloroethyl)ether was detected consistently, and its detection corresponds with areas of VOC contamination.

Several metals have been detected in groundwater samples at the Site, but the detections have been inconsistent and appear to be naturally occurring, possibly related to changes in the aquifer chemistry due to natural degradation of the organic compounds. Specifically, concentrations of arsenic and lead in groundwater have been the main inorganic concern at the Site. Concentrations of arsenic in groundwater samples from three upper aquifer wells, MW06, MW15, and MW43, have consistently exceeded the U.S. EPA MCL for arsenic. Exceedances of arsenic have occurred at a few other wells; however, these exceedances have occurred either inconsistently or not in the past three years. Most exceedances of the MCL for lead occurred during 1996 and 1997. Since 1998, only 2 exceedances have occurred, and these were in two different lower aquifer wells.

2.2.3.3 Upper Aquifer Impacts

Based on an evaluation of all historical groundwater data, benzene and chloroethane have consistently delineated the extent of the groundwater impacts. No other compound has been detected consistently as widely and as far from the source as these specific VOCs. As discussed above, these compounds are the most commonly detected groundwater constituents in both the upper and lower aquifers. Therefore, benzene and chloroethane represent the primary contaminants of concern in groundwater surrounding the ACS Site. Further groundwater discussion will focus on these compounds, but will not eliminate other compounds from being of concern. Table 3 summarizes the analytical results for benzene and chloroethane in the 23 upper aquifer wells over the past 17 sampling events. This tabulation lists the location of the wells relative to Site contamination, the 1996-1997 baseline maximum concentrations for benzene and chloroethane, the concentrations and dates of the highest detection of these compounds, and the concentrations and dates of the most recent results.

Results from upgradient and downgradient monitoring wells have been consistently free of Site-related contaminants. Only results from downgradient well MW14 have had somewhat consistent detections of benzene and chloroethane, although recent results have shown decreasing trends. Results from interior wells indicate that concentrations of benzene and chloroethane are either consistent or decreasing.

Appendix A provides concentration-versus-time plots of benzene and chloroethane for all 23 wells in the upper aquifer monitoring network. The results show either stable or decreasing concentration trends at most locations.

2.2.3.4 Lower Aquifer Impacts

Table 4 summarizes the analytical results for benzene and chloroethane in the 21 lower aquifer wells over the past 17 sampling events.

Results from replacement well MW09R have been decreasing since its installation. Sample results from MW10C have fluctuated over the past few years. Due to the uncertainty of the installation methods used, and because benzene was detected at increasing concentrations in ATMW4D, this well was abandoned and replaced with MW56 in April 2001. Another nearby well of unknown construction, W-1, was also abandoned to eliminate it as a potential pathway for groundwater to migrate from the upper to lower aquifer. Since installation, sample results from MW56 have not shown any VOCs. Concentrations of benzene and chloroethane at MW10C have also decreased.

Appendix A provides concentration-versus-time plots for 17 of the 21 monitoring wells in the lower aquifer monitoring network. Only three of the wells, MW09R, MW10C, and ATMW4D have shown concentrations above 6 µg/L.

2.3 SUMMARY

Groundwater flow and hydraulic gradients in the upper and lower aquifers have been consistent throughout the five years of data collection under the current approved monitoring plan. Since the completion of the PGCS and BWES, groundwater flow in the upper aquifer has consistently been east to west, with groundwater flowing around the barrier wall to the north and south. Groundwater flow in the lower aquifer has been northward at a small horizontal gradient. Vertical gradients in the upper aquifer have been small and upward, typical of a wetland environment. Vertical gradients in the lower aquifer have been small and variable, indicating that no overall vertical trend exists. There is a strong downward vertical gradient from the upper to lower aquifer.

Groundwater sampling data indicates that benzene and chloroethane have historically defined the extent of impacted groundwater at the site, and the extent of the impacted groundwater has decreased over the past 5 years, primarily due to the effects of remedial actions measures taken at the Site. In the upper aquifer, the groundwater sampling data demonstrate that the BWES is working to contain contaminants inside the barrier wall. Results from several monitoring wells outside the barrier wall, but inside the impacted groundwater zones, show that concentrations in contaminated groundwater areas may be decreasing. Results from upgradient, downgradient, and transgradient monitoring wells have been consistently free of Site-related contaminants, indicating that contamination outside of the barrier wall has not migrated beyond its historical extent. These results also indicate that the PGCS has been effective in preventing further off-site migration of contaminants in the groundwater. While some concentrations have shown variability, no upward trends exist. Most results are consistently below baseline values and some show decreasing concentration trends.

Lower aquifer sampling data indicates that the detected lower aquifer impacts have been related to faulty well construction at monitoring wells MW09 and ATMW4D. The problem wells have been abandoned and replacement wells have shown decreasing concentrations.

The database developed from the past five years of monitoring provides a strong basis for understanding the groundwater flow system and the impacts to groundwater quality at the Site. The next section provides an evaluation of the parameters, frequency, and locations of the interim monitoring plan and propose modifications to increase the efficiency and reduce redundancy of the monitoring program.

3.0 REVISED GROUNDWATER MONITORING PLAN

The interim monitoring plan was designed with the sampling parameters, locations, and frequency to aid in the refinement of the delineation of the nature and extent of groundwater impact. It utilized monitoring wells installed at the ACS Site during the investigation phases for the purpose of determining the nature and extent of groundwater contamination. The past five years of monitoring have provided a database that comprehensively defines the groundwater flow regime and groundwater quality of the upper and lower aquifers at the Site. Therefore, it is reasonable to modify the monitoring plan to meet the specific objectives for groundwater monitoring during the remedial action and operation and maintenance phases of the project.

The first step in revising the Plan is to refine and update the overall monitoring objectives in terms that are appropriate for the Site understanding and for the remedial actions that have been completed and are ongoing. The second step is to modify the components of the monitoring plan to best meet the revised monitoring objectives.

3.1 OBJECTIVES

The following revised and refocused objectives are proposed for the revised Plan:

1) Collect water level data to confirm that groundwater flow regimes in the upper and lower aquifers are consistent with historical flow patterns.

2) Collect water level data to confirm that the BWES and PGCS are affecting the upper aquifer hydraulic gradients as planned.

3) Collect and analyze groundwater samples from upgradient monitoring wells in the upper and lower aquifers to confirm background groundwater water quality.

4) Collect and analyze groundwater samples from upper and lower aquifer monitoring wells to provide indication of any changes in groundwater quality at downgradient boundaries.

5) Collect and analyze groundwater samples from the interior of the areas of contaminated groundwater to document how concentrations change with time as the remediation progresses.

3.2 COMPONENTS

The components of a monitoring program include 1) water level measurements, 2) sampling parameters, 3) sampling frequency, and 4) sampling locations. The following sections provide the basis for revising each of these components for the future long-term groundwater monitoring.

3.2.1 Water Level Measurements

Water levels have been measured every quarter for the past five years at approximately 160 locations, including monitoring wells and piezometers in the upper and lower aquifer and staff gages representing surface water bodies. The resulting database provides a comprehensive record of water levels, which have been used to document the groundwater flow regime and hydraulic gradients within and between the upper and lower aquifers. While groundwater levels have risen and fallen each year in response to the annual hydrograph, the overall groundwater flow patterns have been consistent. Water levels measured at a subset of these locations will be sufficient to meet objective 1, which is confirming groundwater flow regimes in the upper and lower aquifers are consistent with historical flow patterns.

In order to meet Objective 2, water level measurements will be collected on a quarterly basis from 46 monitoring wells and piezometers in the upper aquifer. These measurements will be used to evaluate the performance of the PGCS and BWES as laid out in the Performance Standard Verification Plan (PSVP).

Table 5 is a listing of all the upper aquifer water level measurement points that have been used during the past five years of monitoring. The table provides an indication of the location of each well, piezometer, and staff gauge, and indicates which groundwater monitoring objective is addressed by that measurement point. Measurement points that are unnecessary for future monitoring are shaded, and reasons for inclusion or exclusion are summarized in the "Notes" column. A total of 70 upper aquifer water level measurement points are recommended for inclusion in the revised Plan. These water level measurement locations are shown in Figure 1.

Table 6 provides a similar tabulation for the lower aquifer water level measurement points. Five years of hydraulic data from these points show that the groundwater flow direction and vertical and horizontal gradients have remained consistent over time. Shading on the table show which wells are not recommended for future monitoring. Water level measurements at twelve locations will be sufficient to meet objective 1 and provide a record of the continuing consistency or variability from the historical groundwater flow regime. The twelve recommended lower aquifer water measurement locations are shown on Figure 2.

3.2.2 Sampling Parameters

As discussed in Section 2.0, the groundwater data shows that VOCs, specifically benzene and chloroethane, have historically defined the extent of the impacted groundwater plume, and are the contaminants of concern in the Site groundwater. The full scan of TCL/TAL parameters have been analyzed for groundwater samples at least once per year for the past five years. Only one SVOC, bis(2-chloroethyl)ether, has been consistently detected at wells with VOC contamination; however, it is not detected outside of the existing plume defined by VOCs. Pesticides and PCBs have not been found in groundwater samples at consistently detectable levels. The data also show that, other than arsenic, no significant, consistent detections of inorganics occur in the site wells, and that detections of inorganics are likely naturally occurring, related to changes in aquifer chemistry due to natural degradation of the organic contaminants.

Therefore, it is reasonable to reduce the analytical parameters in the groundwater monitoring program to the following list of indicator VOCs: benzene, chloroethane, tetrachloroethene, trichloroethene, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, and vinyl chloride.

In addition to the indicator VOCs, a few wells will be sampled for specific compounds that have historically exceeded baseline concentrations. Bis(2-chloroethyl)ether (an SVOC) will be analyzed annually in samples from MW06, MW19, and MW45, and arsenic will be analyzed annually in samples from MW06, MW15, and MW43.

Once during 2003 and 2006, all groundwater samples will be analyzed for the full-scan of TCL/TAL parameters (VOCs, SVOCs, PCBs, pesticides, and inorganics).

The samples collected from the residential wells will continue to be analyzed for low-concentration full-scan TCL/TAL parameters.

3.2.3 Sampling Frequency

The results of previous hydrogeologic investigations indicate that average linear groundwater flow velocities at the ACS Site in both the upper and lower aquifers are in the range of 50 to 100 feet per year. The sampling also shows consistent concentrations at most monitoring wells from one sampling event to the next, and that the objectives of groundwater monitoring can be adequately met with a sampling frequency of once per year.

However, until the Groundwater Remedy is submitted and approved, a semi-annual sampling frequency will be conducted. Analyses of bis(2-chloroethyl)ether and arsenic will be conducted on an annual basis (see Section 3.2.2). A few monitoring wells will be sampled and analyzed on an annual basis (see Section 3.2.4). Water level measurements for Objective 1 will be conducted during the semi-annual sampling events, while measurements for Objective 2 will be conducted on a quarterly basis.

3.2.4 Upper Aquifer Monitoring Locations

For the past five years, twenty-three monitoring wells in the upper aquifer have been sampled on a quarterly or semi-annually basis. Table 7 summarizes the evaluation of groundwater monitoring locations from the interim monitoring plan. A column is provided for each of the groundwater monitoring objectives 3, 4, and 5. "X's" in the various columns provide an indication of whether each well is needed to meet the objectives of the

Plan. Rows with no "X's" shaded indicate that we propose to eliminate the well from the monitoring network.

North of the Site, monitoring well MW11 will monitor upper aquifer, upgradient water quality, while MW48 and MW49 will continue to monitor the interior of the contaminant plume. Upgradient well MW12, downgradient wells MW13 and MW37, and transgradient well MW39 will be sampled and analyzed on an annual basis to provide additional information. Upgradient and transgradient wells MW38 and MW40 were not included since they have been consistently free of site-related contaminants.

West of the Site, monitoring well MW14 will continue to be monitored. MW46 was not included since sample analyses from this well have not detected any site-related contaminants. Wells M-4S and M-1S, located in the Town of Griffith Landfill, are not included since results from these wells are representative of landfill operations rather than of the ACS Site.

South of the Site, monitoring well MW17 will monitor upgradient conditions (MW17 replaces monitoring well MW18 as the upgradient well, since MW18 has been obstructed), and wells MW06, MW19, and MW45 will monitor the interior of the contaminant plume. Wells MW15, MW42, MW43, and MW44 will monitor the downgradient edge of the impacted groundwater. Wells MW41 and MW47 are not included in the revised Plan since these wells are transgradient to the contaminated zone and samples from these wells have always been free of site-related contaminants.

A total of sixteen upper aquifer monitoring wells are proposed for inclusion in the revised Plan. These include three upgradient wells, eight downgradient or transgradient wells, and five interior wells. The locations of these monitoring wells are shown in Figure 3. Table 8 lists the monitoring schedule for these wells, as well as for piezometers and staff gauges.

3.2.5 Lower Aquifer Monitoring Locations

For the past five years, 21 monitoring wells have monitored lower aquifer water quality. Table 9 summarizes the evaluation of groundwater monitoring locations. Columns have been included to indicate if the well will be used for groundwater monitoring objectives 3, 4, or 5. Shaded rows indicate that the well is not necessary to meet any of the objectives.

Monitoring well MW28 will serve as an upgradient monitoring point, and wells MW09R, MW10C, MW29, and MW56 will monitor the interior of the plume, where there are indications of leakage from the upper aquifer along faulty well points. (The faulty wells, MW09, ATMW4D, and W-1 have been removed and properly abandoned).

Groundwater flow is to the north in the lower aquifer. Therefore, the appropriate locations to monitor for potential future Site impacts are along the northern boundary of the Site. An array of monitoring wells has been constructed along the north property line.

The following wells are arrayed along the northern boundary of the Site in four groups.

- MW52, MW53
- MW51, MW33, MW30
- MW54R, MW55
- MW8, MW31, MW32

The first listed well in each group is screened at the top of the lower aquifer and the last listed well is screened at the bottom of the lower aquifer. The middle listed well in the second and fourth groups are screened at an intermediate depth within the lower aquifer.

Sixteen total monitoring wells are proposed for inclusion in the monitoring program for the lower aquifer. These include one upgradient well, eleven downgradient wells, and four interior wells. Table 10 lists the monitoring schedule for these monitoring wells. Their locations are shown in Figure 4.

3.2.6 Residential Wells

Table 11 lists the up to five residential wells to be sampled annually in the revised Plan. These wells will be sampled during the 3rd quarter of each year. The locations of these five wells are shown in Figure 5. Both U.S. EPA and IDEM will be notified of the residential well sampling activities four weeks prior to the planned event.

3.3 CORRECTIVE ACTION

3.3.1 Water Level Measurements

Following the collection of water level measurements during each sampling event, water level elevations will be calculated and compared to historical values, before the field activities have been completed. If the water level for a given well, piezometer, or staff gauge is anomalously high or low[2], the water level will be checked for field error by re-measurement. If the anomalous level is confirmed, adjacent monitoring wells will be re-measured to see if they are a source of error. If the anomaly is confirmed, the situation will be evaluated and the results and any recommended actions will be communicated to the U.S. EPA in writing.

3.3.2 Analytical Results

When the analytical results for a sampling round have been validated, the concentrations of benzene and chloroethane will be compared to the existing baseline concentrations at each well. Table 12 provides a summary of the baseline concentrations for the indicator analytical parameters at each monitoring well.

If sample results exceed the baseline concentrations, a response including the data and an explanation will be provided to the Agencies. Based on the magnitude and location of the

[2] An anomalous water level is one that either falls outside the normal range for that location or is unrealistically high or low when compared to measurement points adjacent to that point.

exceedance, the response may also include recommendations for re-sampling or other specific corrective action.

3.3.3 Monitoring Point Replacement

On occasion, monitoring wells, piezometers, and staff gauges can be damaged or destroyed. If one of these sampling points is incapable of providing the measurement or sample required during a given sampling round, the damage will be noted. A letter will be written to U.S. EPA recommending the action to be taken at that location. MWH will not be responsible for the piezometers in the Town of Griffith Landfill.

3.4 REPORTING

The data from each sampling event will be provided to the U.S. EPA and IDEM in tabular form attached to the next monthly status report after data validation is completed. In addition, an annual groundwater monitoring report will be submitted within 60 days after data validation is completed. The report will provide tables and figures of the water level and analytical data, and the text will provide a discussion of the results. Appendices will include updated concentration-versus-time plots and the validated analytical data.

4.0 REFERENCES

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TABLES

Table 1
Summary of Analytical Detections - Upper Aquifer
American Chemical Service NPL Site, Griffith, Indiana

Constituent	Sample Locations	No. of Samples Collected	No. of Samples with Detected Analytes	Frequency of Detection	Maximum Detected Concentration (µg/L)	Minimum Detected Concentration (µg/L)
Volatile Organic Compounds						
Benzene*	24	339	154	45.4%	9500	0.1
Chloroethane*	24	339	135	39.8%	2000	0.5
Methylene chloride	24	230	45	19.6%	140	0.3
Acetone	24	229	38	16.6%	170	1
1,2-Dichloroethene (total)	24	225	34	15.1%	130	0.1
trans-1,2-Dichloroethene*	23	108	13	12.0%	4	1
Isopropylbenzene	18	18	2	11.1%	16	2
1,2-Dibromo-3-chloropropane	18	19	2	10.5%	6	2
1,2-Dichlorobenzene	18	19	2	10.5%	4	1
Methyl tert-butyl ether	19	19	2	10.5%	2	1
Chlorobenzene	24	230	24	10.4%	42	0.2
Xylenes (total)	24	229	19	8.3%	3900	1
Ethylbenzene	24	229	14	6.1%	770	1
1,4-Dichlorobenzene	18	18	1	5.6%	2	2
Chloromethane	24	229	11	4.8%	960	0.1
1,2-Dichloroethane*	24	254	10	3.9%	88	0.2
Toluene	24	230	9	3.9%	3	1
Vinyl chloride*	24	339	13	3.8%	4	0.2
4-Methyl-2-pentanone	24	229	8	3.5%	63	2
1,1-Dichloroethane*	24	229	7	3.1%	21	0.3
2-Butanone	24	216	3	1.4%	2	1
2-Hexanone	24	216	3	1.4%	2	1
Tetrachloroethene*	24	326	4	1.2%	200	1
1,1,2,2-Tetrachloroethane	24	216	2	0.9%	2	2
cis-1,2-Dichloroethene*	23	108	1	0.9%	0.1	0.1
Trichloroethene*	24	325	3	0.9%	45	1
Bromoform	24	216	1	0.5%	1	1
Carbon disulfide	24	216	1	0.5%	0.1	0.1
Chloroform	24	229	1	0.4%	0.3	0.3
1,1,1-Trichloroethane	24	326	0	0.0%	0	0
1,1,2-Trichloroethane	24	326	0	0.0%	0	0
1,1-Dichloroethene*	24	325	0	0.0%	0	0
1,2,4-Trichlorobenzene	18	18	0	0.0%	0	0
1,2-Dibromoethane	18	19	0	0.0%	0	0
1,2-Dichloropropane	24	216	0	0.0%	0	0
1,3-Dichlorobenzene	18	18	0	0.0%	0	0
Bromodichloromethane	24	229	0	0.0%	0	0

Table 1
Summary of Analytical Detections - Upper Aquifer
American Chemical Service NPL Site, Griffith, Indiana

Constituent	Sample Locations	No. of Samples Collected	No. of Samples with Detected Analytes	Frequency of Detection	Maximum Detected Concentration (µg/L)	Minimum Detected Concentration (µg/L)
Bromomethane	24	216	0	0.0%	0	0
Carbon tetrachloride	24	216	0	0.0%	0	0
cis-1,3-Dichloropropene	24	216	0	0.0%	0	0
Dibromochloromethane	24	216	0	0.0%	0	0
Dichlorodifluoromethane	19	19	0	0.0%	0	0
Styrene	24	216	0	0.0%	0	0
trans-1,3-Dichloropropene	24	216	0	0.0%	0	0
Trichlorofluoromethane	19	19	0	0.0%	0	0
Vinyl acetate	9	20	0	0.0%	0	0
Semivolatile Organic Compounds						
Phenol	24	217	70	32.26%	160	2
bis(2-chloroethyl)ether	24	217	59	27.19%	85	1
bis (2-ethylhexyl)phthalate	24	217	35	16.13%	50	1
Benzoic acid	7	13	2	15.38%	11	9
2,2'oxybis(1-Chloropropane)	24	217	27	12.44%	170	1
Isophorone	24	217	21	9.68%	35	0.9
Naphthalene	24	218	13	5.96%	140	2
2-Methylnaphthalene	24	217	12	5.53%	24	0.5
Di-n-butylphthalate	24	204	11	5.39%	2.75	0.5
1,2-Dichlorobenzene	24	186	5	2.69%	5	2
Diethylphthalate	24	204	5	2.45%	4	1
1,4-Dichlorobenzene	24	200	4	2.00%	11	2
2,4-Dimethylphenol	24	204	4	1.96%	58	3
4-Methylphenol	24	217	4	1.84%	12	3
2-Methylphenol	24	204	3	1.47%	5	2
Dimethylphthalate	24	204	3	1.47%	9	2.9
Pentachlorophenol	24	204	2	0.98%	3	2
2,6-Dichlorophenol	24	217	2	0.92%	0.9	0.9
Anthracene	24	204	1	0.49%	10.5	10.5
Di-n-octylphthalate	24	204	1	0.49%	47	47
1,2,4-Trichlorobenzene	24	187	0	0.00%	0	0
1,3-Dichlorobenzene	24	187	0	0.00%	0	0
2,4,5-Trichlorophenol	24	204	0	0.00%	0	0
2,4,6-Trichlorophenol	24	204	0	0.00%	0	0
2,4-Dichlorophenol	24	204	0	0.00%	0	0
2,4-Dinitrophenol	24	204	0	0.00%	0	0
2,4-Dinitrotoluene	24	204	0	0.00%	0	0
2,6-Dinitrotoluene	24	204	0	0.00%	0	0

Table 1
Summary of Analytical Detections - Upper Aquifer
American Chemical Service NPL Site, Griffith, Indiana

Constituent	Sample Locations	No. of Samples Collected	No. of Samples with Detected Analytes	Frequency of Detection	Maximum Detected Concentration (μg/L)	Minimum Detected Concentration (μg/L)
2-Chloronaphthalene	24	204	0	0.00%	0	0
2-Chlorophenol	24	204	0	0.00%	0	0
2-Nitroaniline	24	204	0	0.00%	0	0
2-Nitrophenol	24	204	0	0.00%	0	0
3,3'-Dichlorobenzidine	24	204	0	0.00%	0	0
3-Nitroaniline	24	204	0	0.00%	0	0
4,6-Dinitro-2-methylphenol	24	204	0	0.00%	0	0
4-Bromophenyl-phenyl ether	24	204	0	0.00%	0	0
4-Chloro-3-methylphenol	24	204	0	0.00%	0	0
4-Chloroaniline	24	204	0	0.00%	0	0
4-Chlorophenyl-phenyl ether	24	204	0	0.00%	0	0
4-Nitroaniline	24	204	0	0.00%	0	0
4-Nitrophenol	24	204	0	0.00%	0	0
Acenaphthylene	24	204	0	0.00%	0	0
Acenapthene	24	204	0	0.00%	0	0
Acetophenone	18	18	0	0.00%	0	0
Benzo(a)anthracene	24	204	0	0.00%	0	0
Benzo(a)pyrene	24	204	0	0.00%	0	0
Benzo(b)fluoranthene	24	204	0	0.00%	0	0
Benzo(g,h,I)perylene	24	204	0	0.00%	0	0
Benzo(k)fluoranthene	24	204	0	0.00%	0	0
Benzyl alcohol	7	13	0	0.00%	0	0
bis(2-chloroethoxy)methane	24	204	0	0.00%	0	0
Butylbenzylphthalate	24	204	0	0.00%	0	0
Carbazole	24	191	0	0.00%	0	0
Chrysene	24	204	0	0.00%	0	0
Dibenzo(a,h)anthracene	24	204	0	0.00%	0	0
Dibenzofuran	24	204	0	0.00%	0	0
Fluoranthene	24	204	0	0.00%	0	0
Fluorene	24	204	0	0.00%	0	0
Hexachlorobenzene	24	204	0	0.00%	0	0
Hexachlorobutadiene	24	205	0	0.00%	0	0
Hexachlorocyclopentadiene	24	204	0	0.00%	0	0
Hexachloroethane	24	204	0	0.00%	0	0
Indeno(1,2,3-cd)pyrene	24	204	0	0.00%	0	0
Nitrobenzene	24	204	0	0.00%	0	0
N-Nitroso-di-n-propylamine	24	204	0	0.00%	0	0
N-Nitrosodiphenylamine	24	204	0	0.00%	0	0

Table 1
Summary of Analytical Detections - Upper Aquifer
American Chemical Service NPL Site, Griffith, Indiana

Constituent	Sample Locations	No. of Samples Collected	No. of Samples with Detected Analytes	Frequency of Detection	Maximum Detected Concentration (µg/L)	Minimum Detected Concentration (µg/L)
Phenanthrene	24	204	0	0.00%	0	0
Pyrene	24	204	0	0.00%	0	0
Polychlorinated biphenyls						
Aroclor-1260	24	203	1	0.49%	27	27
Aroclor-1016	24	203	0	0.00%	0	0
Aroclor-1221	24	203	0	0.00%	0	0
Aroclor-1232	24	203	0	0.00%	0	0
Aroclor-1242	24	203	0	0.00%	0	0
Aroclor-1248	24	203	0	0.00%	0	0
Aroclor-1254	24	203	0	0.00%	0	0
Pesticides						
beta-BHC	24	183	15	8.20%	0.36	0.0055
delta-BHC	24	183	11	6.01%	0.047	0.0012
gamma-BHC	24	183	11	6.01%	0.028	0.0022
Heptachlor	24	183	10	5.46%	0.014	0.0018
alpha-BHC	24	183	9	4.92%	0.011	0.0032
4,4'-DDE	24	183	7	3.83%	0.0086	0.00088
Endrin	24	183	7	3.83%	0.021	0.00074
Heptachlor epoxide	24	183	7	3.83%	0.035	0.0011
Methoxychlor	24	183	7	3.83%	0.11	0.0021
Endrin ketone	24	183	6	3.28%	0.0065	0.002
Aldrin	24	183	5	2.73%	0.014	0.0018
alpha-Chlordane	24	183	5	2.73%	0.0068	0.0048
gamma-Chlordane	24	183	5	2.73%	0.02	0.0011
4,4'-DDT	24	183	4	2.19%	0.068	0.0081
Endosulfan II	24	183	4	2.19%	0.033	0.0019
Dieldrin	24	183	3	1.64%	0.047	0.0069
4,4'-DDD	24	183	2	1.09%	0.036	0.017
Endosulfan sulfate	24	183	1	0.55%	0.027	0.027
Endosulfan I	24	183	0	0.00%	0	0
Endrin aldehyde	23	170	0	0.00%	0	0
Toxaphene	24	183	0	0.00%	0	0

Note:
* = Denotes Indicator VOC parameters included in revised monitoring plan.

Table 2
Summary of Analytical Detections - Lower Aquifer
American Chemical Service NPL Site, Griffith, Indiana

Constituent	Sample Locations	No. of Samples Collected	Samples with Detected Analytes	Frequency of Detection	Maximum Detected Concentration (µg/L)	Minimum Detected Concentration (µg/L)
Volatile Organic Compounds						
Benzene*	22	300	63	21.0%	3500	0.1
Chloroethane*	21	300	54	18.0%	2900	0.1
Acetone	21	199	32	16.1%	990	1
Methylene chloride	21	199	30	15.1%	130	1
Toluene	21	198	12	6.1%	3	0.4
4-Methyl-2-pentanone	21	199	10	5.0%	50	1
Xylenes (total)	21	199	5	2.5%	2	0.2
2-Butanone	21	199	4	2.0%	260	1
Chloromethane	21	199	4	2.0%	16	0.1
Carbon disulfide	21	199	3	1.5%	0.2	0.2
Chloroform	21	199	2	1.0%	1	1
Ethylbenzene	21	199	2	1.0%	2	0.1
Vinyl chloride*	22	299	3	1.0%	128.5	4
1,2-Dichloroethene (total)	21	203	2	1.0%	1	1
1,2-Dichloroethane*	21	218	2	0.9%	2	1
1,1,1-Trichloroethane	22	300	0	0.0%	0	0
1,1,2,2-Tetrachloroethane	21	198	0	0.0%	0	0
1,1,2-Trichloroethane	22	301	0	0.0%	0	0
1,1-Dichloroethane*	21	199	0	0.0%	0	0
1,1-Dichloroethene*	22	298	0	0.0%	0	0
1,2,4-Trichlorobenzene	18	18	0	0.0%	0	0
1,2-Dibromo-3-chloropropane	18	18	0	0.0%	0	0
1,2-Dibromoethane	18	18	0	0.0%	0	0
1,2-Dichlorobenzene	18	22	0	0.0%	0	0
1,2-Dichloropropane	21	199	0	0.0%	0	0
1,3-Dichlorobenzene	18	18	0	0.0%	0	0
1,4-Dichlorobenzene	18	18	0	0.0%	0	0
2-Hexanone	21	199	0	0.0%	0	0
Bromodichloromethane	21	199	0	0.0%	0	0
Bromoform	21	199	0	0.0%	0	0
Bromomethane	21	199	0	0.0%	0	0
Carbon tetrachloride	21	199	0	0.0%	0	0
Chlorobenzene	21	199	0	0.0%	0	0
cis-1,2-Dichloroethene*	22	93	0	0.0%	0	0
cis-1,3-Dichloropropene	21	199	0	0.0%	0	0
Dibromochloromethane	21	199	0	0.0%	0	0
Dichlorodifluoromethane	18	18	0	0.0%	0	0
Isopropylbenzene	18	18	0	0.0%	0	0

Table 2
Summary of Analytical Detections - Lower Aquifer
American Chemical Service NPL Site, Griffith, Indiana

Constituent	Sample Locations	No. of Samples Collected	Samples with Detected Analytes	Frequency of Detection	Maximum Detected Concentration (µg/L)	Minimum Detected Concentration (µg/L)
Methyl tert-butyl ether	18	18	0	0.0%	0	0
Styrene	21	199	0	0.0%	0	0
Tetrachloroethene*	22	300	0	0.0%	0	0
trans-1,2-Dichloroethene*	22	93	0	0.0%	0	0
trans-1,3-Dichloropropene	21	199	0	0.0%	0	0
Trichloroethene*	22	300	0	0.0%	0	0
Trichlorofluoromethane	18	18	0	0.0%	0	0
Vinyl acetate	6	16	0	0.0%	0	0
Semivolatile Organic Compounds						
Phenol	21	187	77	41.18%	340	2
bis (2-ethylhexyl)phthalate	21	187	58	31.02%	76	0.9
bis(2-chloroethyl)ether	21	187	16	8.56%	44	2
Isophorone	21	187	15	8.02%	5	0.7
Di-n-butylphthalate	21	187	4	2.14%	1	0.7
2,2'oxybis(1-Chloropropane)	21	187	3	1.60%	6.5	1.25
Anthracene	21	187	3	1.60%	0.9	0.7
Butylbenzylphthalate	21	187	2	1.07%	2	1
Diethylphthalate	21	187	2	1.07%	16	8
Di-n-octylphthalate	21	187	2	1.07%	3	1
N-Nitroso-di-n-propylamine	21	187	2	1.07%	6.5	6.3
4-Chloro-3-methylphenol	21	187	1	0.53%	4	4
4-Methylphenol	21	187	1	0.53%	10.5	10.5
4-Nitrophenol	21	187	1	0.53%	19	19
Dimethylphthalate	21	187	1	0.53%	9	9
Pentachlorophenol	21	187	1	0.53%	3	3
1,2,4-Trichlorobenzene	21	169	0	0.00%	0	0
1,2-Dichlorobenzene	21	169	0	0.00%	0	0
1,3-Dichlorobenzene	21	173	0	0.00%	0	0
1,4-Dichlorobenzene	21	173	0	0.00%	0	0
2,4,5-Trichlorophenol	21	187	0	0.00%	0	0
2,4,6-Trichlorophenol	21	187	0	0.00%	0	0
2,4-Dichlorophenol	21	187	0	0.00%	0	0
2,4-Dimethylphenol	21	187	0	0.00%	0	0
2,4-Dinitrophenol	21	187	0	0.00%	0	0
2,4-Dinitrotoluene	21	187	0	0.00%	0	0
2,6-Dichlorophenol	21	187	0	0.00%	0	0
2,6-Dinitrotoluene	21	187	0	0.00%	0	0
2-Chloronaphthalene	21	187	0	0.00%	0	0
2-Chlorophenol	21	187	0	0.00%	0	0

Table 2
Summary of Analytical Detections - Lower Aquifer
American Chemical Service NPL Site, Griffith, Indiana

Constituent	Sample Locations	No. of Samples Collected	Samples with Detected Analytes	Frequency of Detection	Maximum Detected Concentration (µg/L)	Minimum Detected Concentration (µg/L)
2-Methylnaphthalene	21	187	0	0.00%	0	0
2-Methylphenol	21	187	0	0.00%	0	0
2-Nitroaniline	21	187	0	0.00%	0	0
2-Nitrophenol	21	187	0	0.00%	0	0
3,3'-Dichlorobenzidine	21	187	0	0.00%	0	0
3-Nitroaniline	21	187	0	0.00%	0	0
4,6-dinitro-2-methylphenol	21	187	0	0.00%	0	0
4-Bromophenyl-phenyl ether	21	187	0	0.00%	0	0
4-Chloroaniline	21	187	0	0.00%	0	0
4-Chlorophenyl-phenyl ether	21	187	0	0.00%	0	0
4-Nitroaniline	21	187	0	0.00%	0	0
Acenaphthylene	21	187	0	0.00%	0	0
Acenaphthene	21	187	0	0.00%	0	0
Acetophenone	18	18	0	0.00%	0	0
Benzo(a)anthracene	21	187	0	0.00%	0	0
Benzo(a)pyrene	21	187	0	0.00%	0	0
Benzo(b)fluoranthene	21	187	0	0.00%	0	0
Benzo(g,h,i)perylene	21	187	0	0.00%	0	0
Benzo(k)fluoranthene	21	187	0	0.00%	0	0
Benzoic acid	4	8	0	0.00%	0	0
Benzyl alcohol	4	8	0	0.00%	0	0
bis(2-chloroethoxy)methane	21	187	0	0.00%	0	0
Carbazole	21	179	0	0.00%	0	0
Chrysene	21	187	0	0.00%	0	0
Dibenzo(a,h)anthracene	21	187	0	0.00%	0	0
Dibenzofuran	21	187	0	0.00%	0	0
Fluoranthene	21	187	0	0.00%	0	0
Fluorene	21	187	0	0.00%	0	0
Hexachlorobenzene	21	187	0	0.00%	0	0
Hexachlorobutadiene	21	187	0	0.00%	0	0
Hexachlorocyclopentadiene	21	187	0	0.00%	0	0
Hexachloroethane	21	187	0	0.00%	0	0
Indeno(1,2,3-cd)pyrene	21	187	0	0.00%	0	0
Naphthalene	21	187	0	0.00%	0	0
Nitrobenzene	21	187	0	0.00%	0	0
N-Nitrosodiphenylamine	21	187	0	0.00%	0	0
Phenanthrene	21	187	0	0.00%	0	0
Pyrene	21	187	0	0.00%	0	0

Table 2
Summary of Analytical Detections - Lower Aquifer
American Chemical Service NPL Site, Griffith, Indiana

Constituent	Sample Locations	No. of Samples Collected	Samples with Detected Analytes	Frequency of Detection	Maximum Detected Concentration (µg/L)	Minimum Detected Concentration (µg/L)
Polychlorinated biphenyls						
Aroclor-1016	21	188	0	0.00%	0	0
Aroclor-1221	21	188	0	0.00%	0	0
Aroclor-1232	21	188	0	0.00%	0	0
Aroclor-1242	21	188	0	0.00%	0	0
Aroclor-1248	21	188	0	0.00%	0	0
Aroclor-1254	21	188	0	0.00%	0	0
Aroclor-1260	21	188	0	0.00%	0	0
Pesticides						
beta-BHC	21	168	17	10.12%	0.025	0.004
delta-BHC	21	168	17	10.12%	0.034	0.00086
Heptachlor epoxide	21	168	13	7.74%	0.013	0.0012
alpha-BHC	21	168	8	4.76%	0.03	0.0011
Heptachlor	21	168	7	4.17%	0.025	0.0022
Methoxychlor	21	168	6	3.57%	0.01	0.0025
Dieldrin	21	168	5	2.98%	0.0019	0.00082
Endrin ketone	21	168	5	2.98%	0.013	0.0038
alpha-Chlordane	21	168	4	2.38%	0.01	0.0014
Endosulfan I	21	168	3	1.79%	0.0034	0.0012
Endrin	21	168	3	1.79%	0.01	0.00095
gamma-BHC	21	168	3	1.79%	0.0025	0.0011
Aldrin	21	167	2	1.20%	0.0061	0.00086
4,4'-DDD	21	168	2	1.19%	0.0024	0.0024
4,4'-DDE	21	168	2	1.19%	0.0046	0.00087
gamma-Chlordane	21	168	2	1.19%	0.0078	0.0018
Endosulfan sulfate	21	168	1	0.60%	0.00096	0.00096
Endrin aldehyde	21	168	1	0.60%	0.011	0.011
4,4'-DDT	21	168	0	0.00%	0	0
Endosulfan II	21	168	0	0.00%	0	0
Toxaphene	21	168	0	0.00%	0	0

Note:
* = Denotes Indicator VOC parameters included in revised monitoring plan.

Table 3

Summary of Historical Groundwater Monitoring Results - Upper Aquifer
American Chemical Service NPL Site, Griffith, Indiana

	Well Identification	Area of Groundwater Contamination	Location with Respect to Area of Groundwater Contamination	1996-1997 Baseline Maximum		Highest Detection since 1996				Most Recent Results		
						Benzene		Chloroethane				
				Benzene	Chloroethane	Conc.	Date	Conc.	Date	Benzene	Chloroethane	Date
1	MW11	North	Upgradient	10	10	2	Nov-99	10 U	---	10 U	10 U	Mar-02
2	MW12		Upgradient	10	10	16	Dec-98	10 U	---	10 U	10 U	Mar-02
3	MW13		Downgradient*	610	570	610	Jun-97	570	Jun-97	10 U	10 U	Mar-02
4	MW37		Downgradient	10	10	1	Mar-00	10 U	---	10 U	10 U	Mar-02
5	MW38		Transgradient	10	10	10 U	---	10 U	---	10 U	10 U	Jun-01
6	MW39		Transgradient	12	10	12	Aug-96	5	Aug-96	1	10 U	Mar-02
7	MW40		Upgradient	10	10	10 U	---	10 U	---	10 U	10 U	Jun-01
8	MW48		Interior	9,500	1,000	9,500	Sep-97	1,000	Aug-96	1,200	33	Mar-02
9	MW49		Interior	6,750	715	6,750	Sep-97	715	Jun-97	200	10 U	Mar-02
10	MW14	West	Downgradient	41	1,000	41	Nov-96	1,000	Nov-96	1	10 U	Mar-02
11	MW46		Downgradient	10	10	2	Sep-97	10 U	---	10 U	10 U	Jun-01
12	M-1S		Griffith Landfill	10	10	2	Mar-00	2	Sep-97	4	10 U	Jun-01
13	M-4S		Griffith Landfill	190	1,300	190	Jun-97	2,000	Dec-98	140	840	Jun-01
14	MW06	South	Interior	320	720	2,100	Mar-00	840	Dec-98	370	190	Mar-02
15	MW15		Downgradient	10	10	8	Nov-98	2	Nov-98	10 U	10 U	Mar-02
16	MW18		Upgradient	10	10	10 U	---	10 U	---	10 U	10 U	Jun-99
17	MW19		Interior	10	20	7	Sep-00	35	Sep-00	4	25	Mar-02
18	MW41		Downgradient	10	10	10 U	---	10 U	---	10 U	10 U	Jun-01
19	MW42		Downgradient	10	10	2	Mar-02	1	Dec-98	2	10 U	Mar-02
20	MW43		Downgradient	10	10	10 U	---	10 U	---	10 U	10 U	Mar-02
21	MW44		Downgradient	10	10	10 U	---	10 U	---	10 U	10 U	Mar-02
22	MW45		Interior	1,045	215	1,045	Apr-97	820	Sep-00	3	4	Mar-02
23	MW47		Transgradient	10	10	10 U	---	10 U	---	10 U	10 U	Jun-01

Notes:
All concentrations in micrograms per liter (ug/L)
U = analyte not detected above reporting limts
--- = indicates that analyte was not detected during any sampling event
* = MW13 was originally an interior well

CAS/cas/PJV
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Table 4
Summary of Historical Groundwater Monitoring Results - Lower Aquifer
American Chemical Service NPL Site, Griffith, Indiana

	Well Identification	Well Screen Depth in Lower Aquifer	Location with Respect to Area of GW Contamination	1996-1997 Baseline Maximum		Highest Detection since 1996				Most Recent Results		
						Benzene		Chloroethane				
				Benzene	Chloroethane	Conc.	Date	Conc.	Date	Benzene	Chloroethane	Date
1	MW28	Upper	Upgradient	10	10	2	Dec-98	10 U	---	10 U	10 U	Mar-02
2	MW50	Upper	Upgradient	10	10	12	Dec-98	10 U	---	10 U	10 U	Jun-01
3	MW07	Upper	Transgradient	10	10	10 U	---	10 U	---	10 U	10 U	Jun-01
4	MW10C	Upper	Interior	150	420	2,000	Jun-99	2,600	Jun-99	480	460	Mar-02
5	MW9R	Upper	Interior	310	2,900	160	Nov-99	2,300	Dec-98	11	330	Mar-02
6	MW29	Middle	Interior	10	10	3	Jun-97	3	Jun-01	10 U	9	Mar-02
7	MW34	Lower	Interior	10	10	10 U	---	10 U	---	10 U	10 U	Jun-01
8	MW23	Upper	Downgradient	10	10	6	Jun-98	10 U	---	10 U	10 U	Mar-02
9	MW24	Upper	Downgradient	10	10	4	Nov-99	10 U	---	10 U	10 U	Jun-01
10	MW52	Upper	Downgradient	100	100	1	Nov-99	100 U	---	10 U	10 U	Mar-02
11	MW53	Lower	Downgradient	10	10	6	Jun-01	10 U	---	7	10 U	Mar-02
12	MW51	Upper	Downgradient	100	100	2	Jun-98	100 U	---	10 U	10 U	Mar-02
13	MW30	Middle	Downgradient	10	10	3	Sep-00	1	Nov-99	10 U	10 U	Mar-02
14	MW33	Lower	Downgradient	10	10	1	Dec-98	10 U	---	10 U	10 U	Mar-02
15	MW54R	Upper	Downgradient	10	10	6	Dec-98	10 U	---	1	10 U	Mar-02
16	MW55	Lower	Downgradient	10	10	10 U	---	10 U	---	10 U	10 U	Mar-02
17	MW08	Upper	Downgradient	10	10	10 U	---	10 U	---	10 U	10 U	Mar-02
18	MW31	Middle	Downgradient	10	10	10 U	---	10 U	---	10 U	10 U	Mar-02
19	MW32	Lower	Downgradient	10	10	9	Dec-98	10 U	---	10 U	10 U	Mar-02
20	M-4D	Upper	Griffith Landfill	10	10	10 U	---	10 U	---	10 U	10 U	Jun-01
21	ATMW4D	Upper	Interior	NA	NA	3,500	Nov-00	120	Nov-00	1,800	42	Mar-01

Notes:
All concentrations in micrograms per liter (ug/L)
U = analyte not detected above reporting limts
--- = indicates that analyte was not detected during any sampling event
For replacement wells, like MW9R and MW54R, "Highest Detection" concentrations only reflect samples from the replacement well.

Table 5
Evaluation of Upper Aquifer Gauging Points
American Chemical Service NPL Site, Griffith, Indiana

Monitoring Location Identification	Location with Respect to Area of Groundwater Contamination	OBJ #1 (GW Flow)	OBJ #2 (BWES/ PGCS)	NOTES
Monitoring Wells				
MW06	Interior	X		South of Site
MW11	Upgradient	X		North of Site
MW12	Upgradient	X		North of Site
MW13	Downgradient*	X		North of Site
MW14	Downgradient	X		West of Site
MW15	Downgradient	X		South of Site
MW17	Upgradient	X		South of Site
MW18	Upgradient			South of Site, Obstructed
MW19	Interior	X		South of Site
MW37	Downgradient	X		North of Site
MW38	Transgradient	X		North of Site
MW39	Transgradient	X		North of Site
MW40	Upgradient	X		North of Site
MW41	Downgradient	X		South of Site
MW42	Downgradient	X		South of Site
MW43	Downgradient	X		South of Site
MW44	Downgradient	X		South of Site
MW45	Interior	X		South of Site
MW46	Downgradient	X		West of Site
MW47	Transgradient	X		South of Site
MW48	Interior	X		North of Site
MW49	Interior	X		North of Site
M-1S	Griffith Landfill			West of Site
M-4S	Griffith Landfill	X		West of Site
Staff Gauges				
SG1	Griffith Landfill			Destroyed
SG2	Griffith Landfill			Destroyed
SG3	Griffith Landfill			Located in drainage ditch west of Landfill
SG5	Interior	X		North of Site, located in drainage ditch near railroad tracks
SG6	Downgradient			Located in drainage ditch
SG7	ACS facility			Destroyed
SG8R	Downgradient	X		South of Site, Located in pond
SG11	Downgradient			Located in drainage ditch
SG12	Downgradient			Located in drainage ditch
Piezometers				
LW1	Griffith Landfill			Located in Landfill
LW2	Griffith Landfill			Located in Landfill
EW1	ONCA			Destroyed
P3	OFCA			Destroyed
P4	OFCA			Destroyed
P5	OFCA			Destroyed
P6	OFCA			Destroyed
P7	Upgradient			near P105
P8	Upgradient			near MW40
P9	Upgradient			near MW11
P10	OFCA			Destroyed
P11	OFCA			Destroyed
P12	OFCA			Destroyed
P13	Griffith Landfill	X		Griffith Landfill
P15	Griffith Landfill			Griffith Landfill
P16	Griffith Landfill			Griffith Landfill

Table 5
Evaluation of Upper Aquifer Gauging Points
American Chemical Service NPL Site, Griffith, Indiana

Monitoring Location Identification	Location with Respect to Area of Groundwater Contamination	OBJ #1 (GW Flow)	OBJ #2 (BWES/ PGCS)	NOTES
P17	Griffith Landfill	X		Griffith Landfill
P18	Griffith Landfill			Destroyed
P22	Griffith Landfill			Griffith Landfill
P23	Downgradient		X	in wetlands, located near MW14
P24	Downgradient			west of Site, located near P91
P25	Downgradient		X	in wetlands, located near P88
P26	Downgradient		X	in wetlands, located near MW46
P27	Downgradient		X	west of Site, located near MW14
P28	Transgradient		X	north of Site, located near MW08
P29	ONCA			inside Barrier Wall
P30	ONCA			Destroyed
P31	ONCA		X	Will monitor water level inside Barrier wall
P32	ONCA		X	Will monitor water level inside Barrier wall
P35	ONCA			Destroyed
P36	ONCA		X	Will monitor water level inside Barrier wall
P37	ONCA			Destroyed
P38	ONCA			Destroyed
P39	ONCA			inside Barrier Wall
P40	Transgradient		X	north of Site, near P107
P41	Transgradient		X	north of Site, near P107
P49	ONCA		X	inside Barrier Wall
P50	ONCA			Destroyed
P51	Downgradient			west of Landfill
P52	Downgradient			west of wetlands
P53	Downgradient			north of wetlands
P54	Downgradient			north of wetlands
P55	Transgradient			north of Site, near MW48
P56	Transgradient			north of Site, near MW11
P59	Upgradient			east of Site, located near MW40
P60	Upgradient			east of Site, located near MW12
P61	Downgradient			Destroyed
P62	Downgradient			Destroyed
P63	Transgradient			north of Site, located near SG5
P64	Downgradient			west of Site, used for vertical gradient in wetlands
P65	Downgradient			west of Site, used for vertical gradient in wetlands
P66	Downgradient			west of Site, used for vertical gradient in wetlands
P67	Downgradient			west of Site, used for vertical gradient in wetlands
P68	Downgradient			west of Site, used for vertical gradient in wetlands
P69	Downgradient			west of Site, used for vertical gradient in wetlands
P70	Downgradient			west of Site, used for vertical gradient in wetlands
P71	Downgradient			west of Site, used for vertical gradient in wetlands
PGCS Piezometer Sets				
P81	PGCS		X	Located along PGCS to monitor its effects
P82	PGCS		X	Located along PGCS to monitor its effects
P83	PGCS		X	Located along PGCS to monitor its effects
P84	PGCS		X	Located along PGCS to monitor its effects
P85	PGCS		X	Located along PGCS to monitor its effects
P86	PGCS		X	Located along PGCS to monitor its effects
P87	PGCS		X	Located along PGCS to monitor its effects
P88	PGCS		X	Located along PGCS to monitor its effects
P89	PGCS		X	Located along PGCS to monitor its effects
P90	PGCS		X	Located along PGCS to monitor its effects

Table 5
Evaluation of Upper Aquifer Gauging Points
American Chemical Service NPL Site, Griffith, Indiana

Monitoring Location Identification	Location with Respect to Area of Groundwater Contamination	OBJ #1 (GW Flow)	OBJ #2 (BWES/ PGCS)	NOTES
P91	PGCS		X	Located along PGCS to monitor its effects
P92	PGCS		X	Located along PGCS to monitor its effects
BWES Piezometer Pairs				
P93	BWES - ONCA		X	located inside BW. Destroyed, will be replaced.
P94	BWES - ONCA		X	located inside BW. Destroyed, will be replaced.
P95	BWES - OFCA		X	located outside BW.
P96	BWES - OFCA		X	located inside BW.
P97	BWES - OFCA		X	Destroyed. Replaced by P117
P98	BWES - OFCA		X	Destroyed. Replaced by P116
P99	BWES - OFCA		X	Destroyed. Replaced by P115
P100	BWES - OFCA		X	Destroyed. Replaced by P114
P101	BWES - OFCA		X	Destroyed. Replaced by P111
P102	BWES - OFCA		X	Destroyed. Replaced by P110
P103	BWES - OFCA		X	Destroyed. Replaced by P109
P104	BWES - OFCA		X	Destroyed. Replaced by P110
P105	BWES - ONCA		X	located outside BW.
P106	BWES - ONCA		X	located inside BW.
P107	BWES - ONCA		X	located outside BW.
P108	BWES - ONCA		X	located inside BW.
ORC Piezometers				
ORC PZ1	Transgradient			North of Site, located near MW49
ORC PZ2	Transgradient			North of Site, located near MW49
ORC PZ3	Transgradient			North of Site, located near MW49
ORC PZ4	Transgradient			North of Site, located near MW49
ORC PZ5	Transgradient			North of Site, located near MW48
ORC PZ6	Transgradient			North of Site, located near MW48
ORC PZ7	Transgradient			North of Site, located near MW48
ORC PZ8	Transgradient			North of Site, located near MW48

Notes:

OBJ #1 = Objective 1: Collect water level data to document that consistent groundwater flow regimes are observed in the upper and lower aquifers.

OBJ #2 = Objective 2: Collect water level data to document the performance of the PGCS and BWES.

Shaded wells = water level measurement from well not needed to meet Objective 1 or 2.

GW = Groundwater

PGCS = Perimeter Groundwater Containment System

BWES = Barrier Wall Extraction System

* = MW13 was originally an interior well

Table 6
Evaluation of Lower Aquifer Gauging Points
American Chemical Service NPL Site, Griffith, Indiana

Monitoring Location Identification	Well Screen Depth in Lower Aquifer	Location with Respect to Area of GW Contamination	OBJ #1 (GW Flow)	OBJ #2 (BWES/ PGCS)
MW28	Upper	Upgradient	X	
PZ42	Middle	Upgradient		
PZ43	Lower	Upgradient		
MW50	Upper	Upgradient	X	
PZ44	Middle	Upgradient		
MW07	Upper	Transgradient	X	
MW10C	Upper	Interior	X	
MW09R	Upper	Interior	X	
MW29	Middle	Interior		
MW34	Lower	Interior		
MW23	Upper	Downgradient	X	
MW24	Upper	Downgradient	X	
MW52	Upper	Downgradient	X	
MW53	Lower	Downgradient		
MW51	Upper	Downgradient	X	
MW30	Middle	Downgradient		
MW33	Lower	Downgradient		
MW54R	Upper	Downgradient	X	
MW55	Lower	Downgradient		
MW08	Upper	Downgradient	X	
MW31	Middle	Downgradient		
MW32	Lower	Downgradient		
M4D	Upper	Griffith Landfill	X	
ATMW4D	Upper	Interior		

Notes:
OBJ #1 = Objective 1: Collect water level data to document that consistent groundwater flow regimes are observed in the upper and lower aquifers.
OBJ #2 = Objective 2: Collect water level data to document the performance of the PGCS and BWES.
Shaded wells = water level measurement from well not needed to meet Objective 1 or 2.
GW = Groundwater
PGCS = Perimeter Groundwater Containment System
BWES = Barrier Wall Extraction System

Table 7
Evaluation of Upper Aquifer Groundwater Monitoring Wells
American Chemical Service NPL Site, Griffith, Indiana

Well Identification	Area of Groundwater Contamination	Location with Respect to Area of Groundwater Contamination	OBJ #3 Upgradient	OBJ #4 Downgradient	OBJ #5 Interior
MW11	North	Upgradient	X		
MW12		Upgradient	X		
MW13		Downgradient*		X	
MW37		Downgradient		X	
MW38		Transgradient			
MW39		Transgradient		X	
MW40		Upgradient			
MW48		Interior			X
MW49		Interior			X
MW14	West	Downgradient		X	
MW46		Downgradient			
M-1S		Griffith Landfill			
M-4S		Griffith Landfill			
MW06	South	Interior			X
MW15		Downgradient		X	
MW17		Upgradient	X		
MW19		Interior			X
MW41		Downgradient			
MW42		Downgradient		X	
MW43		Downgradient		X	
MW44		Downgradient		X	
MW45		Interior			X
MW47		Transgradient			

Notes:

OBJ #3 = Objective 3: Collect and analyze groundwater samples from upgradient monitoring wells in the upper and lower aquifers to document background groundwater water quality.

OBJ #4 = Objective 4: Collect and analyze groundwater samples from the monitoring wells at the downgradient boundaries of the site to monitor the boundaries of groundwater impacts.

OBJ #5 = Objective 5: Collect and analyze groundwater samples from the interior of the areas of contaminated groundwater to assess progress toward attaining cleanup objectives in these areas.

Shaded wells = groundwater samples from well not needed to meet Objectives 3, 4, or 5.

Long-Term Groundwater Monitoring Plan
Upper Aquifer Wells Monitoring Schedule
American Chemical Service NPL Site

Monitoring Location ID	Location with respect to Site	Location with respect to area of groundwater contamination	2002							2003						2004								2005								2006					
			1st Qtr				3rd Qtr		4th Qtr	1st Qtr		2nd Qtr	3rd Qtr		4th Qtr	1st Qtr				2nd Qtr	3rd Qtr		4th Qtr	1st Qtr				2nd Qtr	3rd Qtr		4th Qtr	1st Qtr		2nd Qtr	3rd Qtr		4th Qtr
			Water Level	VOCs	B(2CE)E	Arsenic	Water Level	VOCs	Water Level	Water Level	Full Scan	Water Level	Water Level	VOCs	Water Level	Water Level	VOCs	B(2CE)E	Arsenic	Water Level	Water Level	VOCs	Water Level	Water Level	VOCs	B(2CE)E	Arsenic	Water Level	Water Level	VOCs	Water Level	Water Level	VOCs	Water Level	Water Level	Full Scan	Water Level
Monitoring Wells																																					
MW11	North	Upgradient	X	X			X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X
MW12		Upgradient	X	X			X			X	X		X			X	X				X			X	X				X			X			X	X	
MW13		Downgradient*	X	X			X		X	X	X	X	X		X	X	X			X	X		X	X	X			X	X		X	X		X	X		X
MW37		Downgradient	X	X			X		X	X	X	X	X		X	X	X			X	X		X	X	X			X	X		X	X		X	X	X	X
MW38		Transgradient	X				X			X			X			X					X			X					X			X			X		
MW39		Transgradient	X	X			X			X	X		X			X	X				X			X	X				X			X			X	X	
MW40		Upgradient	X				X			X			X			X					X			X					X			X			X		
MW48		Interior	X	X			X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X
MW49		Interior	X	X			X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X
MW14	West	Downgradient	X	X			X	X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X	
MW46		Downgradient	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
MW06	South	Interior	X	X	X	X	X	X		X	X		X	X		X	X	X	X		X	X		X	X	X	X		X	X		X	X		X	X	
MW15		Downgradient	X	X		X	X	X		X	X		X	X		X	X		X		X	X		X	X		X		X	X		X	X		X	X	
MW17		Upgradient	X	X			X	X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X	
MW19		Interior	X	X	X		X	X		X	X		X	X		X	X	X			X	X		X	X	X			X	X		X	X		X	X	
MW41		Downgradient	X				X			X			X			X					X			X					X			X			X		
MW42		Downgradient	X	X			X	X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X	
MW43		Downgradient	X	X		X	X	X		X	X		X	X		X	X		X		X	X		X	X		X		X	X		X	X		X	X	
MW44		Downgradient	X	X			X	X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X	
MW45		Interior	X	X			X	X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X	
MW47		Transgradient	X				X			X			X			X					X			X					X			X			X		
M4S		Griffith Landfill	X				X			X			X			X					X			X					X			X			X		
Staff Gauges & Piezometers																																					
P13	South	Griffith Landfill	X				X			X			X			X					X			X					X			X			X		
P17	South	Griffith Landfill	X				X			X			X			X					X			X					X			X			X		
P23	West	Downgradient	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P25	West	Downgradient	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P26	West	Downgradient	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P27	West	Downgradient	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P28	North	Upgradient	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P40	North	Outside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P41	North	Outside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P49	ONCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
SG5	North	Interior	X				X			X			X			X					X			X					X			X			X		
SG8R	South	Downgradient	X				X			X			X			X					X			X					X			X			X		
SG13[1]	West	Wetland Pond	X				X			X			X			X					X			X					X			X			X		
SG14[1]	South	Runoff Pond	X				X			X			X			X					X			X					X			X			X		
PGCS Piezometer Sets																																					
P81	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P82	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P83	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P84	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P85	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P86	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P87	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P88	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P89	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P90	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P91	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P92	Northwest	PGCS Trench	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X

Long-Term Groundwater Monitoring Plan
Upper Aquifer Wells Monitoring Schedule
American Chemical Service NPL Site

Monitoring Location ID	Location with respect to Site	Location with respect to area of groundwater contamination	2002							2003						2004								2005								2006					
			1st Qtr				3rd Qtr		4th Qtr	1st Qtr		2nd Qtr	3rd Qtr		4th Qtr	1st Qtr				2nd Qtr	3rd Qtr		4th Qtr	1st Qtr				2nd Qtr	3rd Qtr		4th Qtr	1st Qtr		2nd Qtr	3rd Qtr		4th Qtr
			Water Level	VOCs	B(2CE)E	Arsenic	Water Level	VOCs	Water Level	Water Level	Full Scan	Water Level	Water Level	VOCs	Water Level	Water Level	VOCs	B(2CE)E	Arsenic	Water Level	Water Level	VOCs	Water Level	Water Level	VOCs	B(2CE)E	Arsenic	Water Level	Water Level	VOCs	Water Level	Water Level	VOCs	Water Level	Water Level	Full Scan	Water Level
BWES Water Level and Piezometer Pairs																																					
P31	ONCA	Inside Barrier Wall	X				X			X			X			X					X			X					X			X			X		
P32	ONCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P36	ONCA	Inside Barrier Wall	X				X			X			X			X					X			X					X			X			X		
P93[2]	ONCA	Outside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P94[2]	ONCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P95	OFCA	Outside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P96	OFCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P105	ONCA	Outside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P106	ONCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P107	ONCA	Outside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P108	ONCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P109	OFCA	Outside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P110	OFCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P111	OFCA	Outside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P112	OFCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
ORCPZ102	South	Griffith Landfill	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P113	OFCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P114	OFCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P115	OFCA	Outside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P116	OFCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P117	OFCA	Outside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X
P118	OFCA	Inside Barrier Wall	X				X		X	X		X	X		X	X				X	X		X	X				X	X		X	X		X	X		X

Notes:
VOC = Sample will be analyzed for Volatile Organic Compounds
B(2CE)E = Sample will be analyzed for bis(2-chloroethyl)ether
Arsenic = Sample will be analyzed for Arsenic
Full Scan = Sample will be analyzed for VOCs, SVOCs, Pesticides, PCBs, Metals, and Cyanide
BWES = Barrier Wall Extraction System
PGCS = Perimeter Groundwater Containment System
OFCA = Off-Site Containment Area
ONCA = On-Site Containment Area
1 = Staff gauges will be placed in the wetlands pond and the detention pond in the Off-Site Area.
2 = P93 and P94 will be replaced during the On Site ISVE well installation.
* = MW13 was originally an interior well

Table 9
Evaluation of Lower Aquifer Groundwater Monitoring Wells
American Chemical Service NPL Site, Griffith, Indiana

Well Identification	Well Screen Depth in Lower Aquifer	Location with Respect to Area of GW Contamination	OBJ #3 Upgradient	OBJ #4 Downgradient	OBJ #5 Interior
MW28	Upper	Upgradient	X		
MW50	Upper	Upgradient			
MW07	Upper	Transgradient			
MW10C	Upper	Interior			X
MW09R	Upper	Interior			X
MW29	Middle	Interior			X
MW34	Lower	Interior			
MW23	Upper	Downgradient		X	
MW24	Upper	Downgradient			
MW52	Upper	Downgradient		X	
MW53	Lower	Downgradient		X	
MW51	Upper	Downgradient		X	
MW30	Middle	Downgradient		X	
MW33	Lower	Downgradient		X	
MW54R	Upper	Downgradient		X	
MW55	Lower	Downgradient		X	
MW08	Upper	Downgradient		X	
MW31	Middle	Downgradient		X	
MW32	Lower	Downgradient		X	
M-4D	Upper	Griffith Landfill			
MW56	Upper	Interior		X	

Notes:

OBJ #3 = Objective 3: Collect and analyze groundwater samples from upgradient monitoring wells in the upper and lower aquifers to document background groundwater water quality.

OBJ #4 = Objective 4: Collect and analyze groundwater samples from the monitoring wells at the downgradient boundaries of the site to monitor the boundaries of groundwater impacts.

OBJ #5 = Objective 5: Collect and analyze groundwater samples from the interior of the areas of contaminated groundwater to assess progress toward attaining cleanup objectives in these areas.

Shaded wells = groundwater samples from well not needed to meet Objectives 3, 4, or 5.

Table 10
Long-Term Groundwater Monitoring Plan
Lower Aquifer Wells Monitoring Schedule
American Chemical Service NPL Site

Well ID	Well Screen Depth in Lower Aquifer	Location with Respect to Area of Groundwater Contamination	2002					2003				2004					2005					2006			
			1st Qtr			3rd Qtr		1st Qtr		3rd Qtr		1st Qtr			3rd Qtr		1st Qtr			3rd Qtr		1st Qtr		3rd Qtr	
			Water Level	VOCs	B(2CE)E	Water Level	VOCs	Water Level	Full Scan	Water Level	VOCs	Water Level	VOCs	B(2CE)E	Water Level	VOCs	Water Level	VOCs	B(2CE)E	Water Level	VOCs	Water Level	VOCs	Water Level	Full Scan
MW28	Upper	Upgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW50	Upper	Upgradient	X			X		X		X		X			X		X			X		X		X	
MW07	Upper	Upgradient	X			X		X		X		X			X		X			X		X		X	
MW10C	Upper	Interior	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW09R	Upper	Interior	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW29	Middle	Interior		X			X		X		X		X			X		X			X		X		X
MW23	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW24	Upper	Downgradient	X			X		X		X		X			X		X			X		X		X	
MW52	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW53	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW51	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW30	Middle	Downgradient		X			X		X		X		X			X		X			X		X		X
MW33	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW08	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW31	Middle	Downgradient		X			X		X		X		X			X		X			X		X		X
MW32	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW54R	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW55	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW56	Upper	Interior		X			X		X		X		X			X		X			X		X		X
M4D	Upper	Griffith Landfill	X			X		X		X		X			X		X			X		X		X	

Notes:
VOCs = Sample will be analyzed for Volatile Organic Compounds
B(2CE)E = Sample will be analyzed for bis(2-chloroethyl)ether
Full Scan = Sample will be analyzed for VOCs, SVOCs, Pesticides, PCBs, Metals, and Cyanide

CAS/cas/PJV
J:/209/0603 ACS/ LTMP/FINAL/Table 8,10B.xls[LAPLan]

Table 11
Residential Wells
Long-Term Groundwater Monitoring Plan
American Chemical Service NPL Site, Griffith, Indiana

	Residential Well Identification	Location with Respect to Area of GW Contamination	Sampling Frequency	Analytical Parameters
1	PW-Y (1002 Reder)	transgradient	Annually - 3rd quarter	Full TCL/TAL Scan
2	PW-A (1007 Reder)	transgradient	Annually - 3rd quarter	Full TCL/TAL Scan
3	PW-B (1009 Reder)	transgradient	Annually - 3rd quarter	Full TCL/TAL Scan
4	PW-C (1029 Reder)	transgradient	Annually - 3rd quarter	Full TCL/TAL Scan
5	PW-D (1033 Reder)	transgradient	Annually - 3rd quarter	Full TCL/TAL Scan

Notes:

TCL/TAL = Target Compound List/Target Analyte List
GW = Groundwater

Table 3.2
Baseline Concentration Values
American Chemical Service NPL Site, Griffith, Indiana

Well Identification	Upper Aquifer															
	MW06	MW11	MW12	MW13	MW14	MW15	MW17*	MW19	MW37	MW39	MW42	MW43	MW44	MW45	MW48	MW49
VOCs																
Benzene	320	10	10	610	41	10	10	10	10	12	10	10	10	1,045	9,500	6,750
Chloroethane	720	10	10	570	1,000	10	10	20	10	10	10	10	10	215	1,000	715
Tetrachloroethene	50	10	10	50	100	10	10	10	10	10	10	10	10	80	500	500
Trichloroethene	50	10	10	50	100	10	10	10	10	10	10	10	10	80	500	500
1,1-Dichloroethene	50	10	10	50	100	10	10	10	10	10	10	10	10	80	500	500
1,2-Dichloroethene (*cis* + *trans*)	26	10	10	50	100	10	10	10	10	10	10	10	10	80	500	500
1,1-Dichloroethane	21	10	10	50	100	10	10	10	10	10	10	10	10	80	500	500
1,2-Dichloroethane	50	10	10	50	100	10	10	10	10	10	10	10	10	80	500	500
Vinyl Chloride	50	10	10	50	100	10	10	10	10	10	10	10	10	80	500	500
SVOCs																
Bis(2-chloroethyl)ether	56							12								
Metals																
Arsenic	72					59						81				

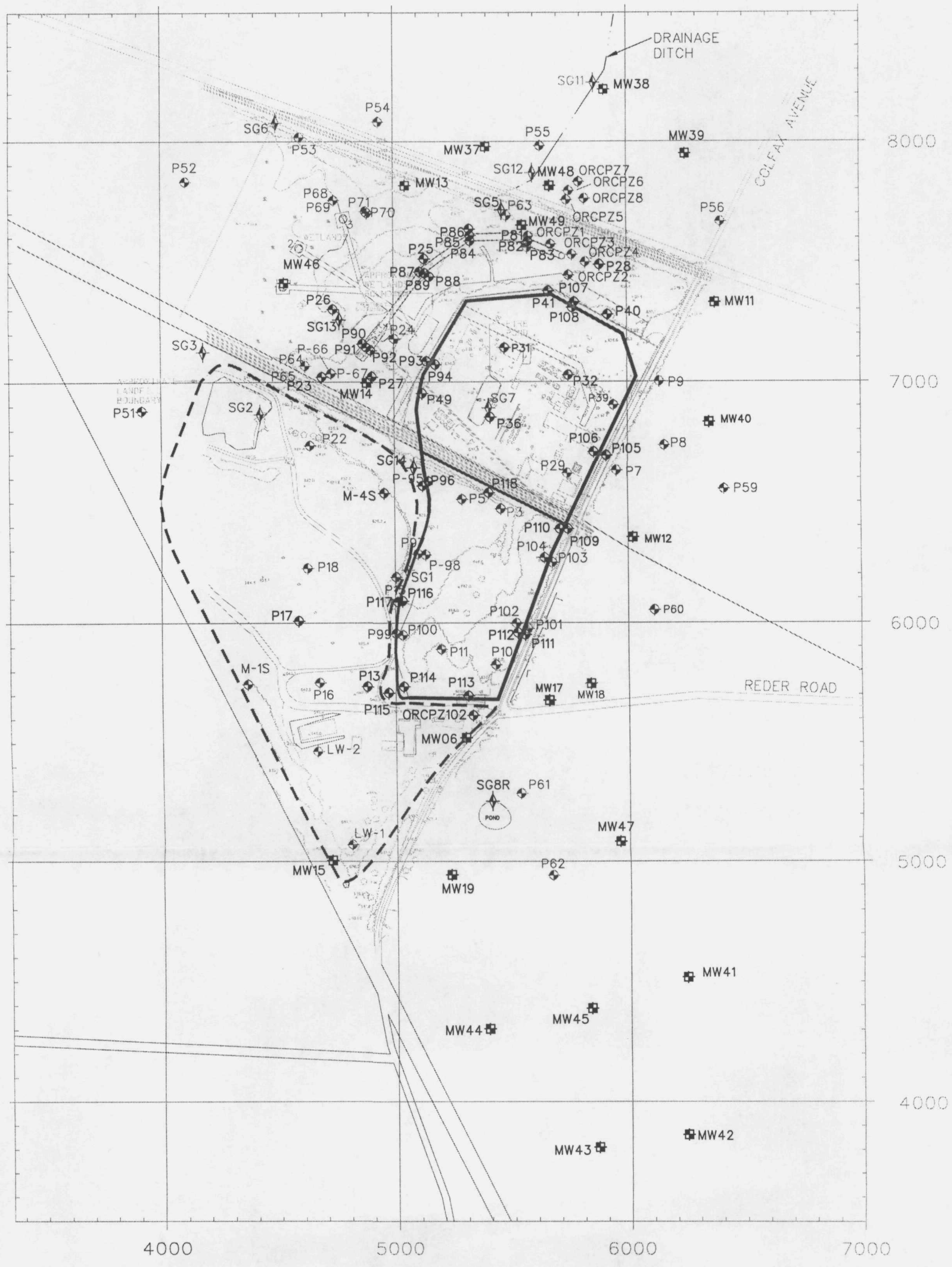
Notes:
All concentrations in micrograms per liter (ug/L)
Values are from *September 1997 Groundwater Sampling Results Report and Groundwater Monitoring Plan (July 1998), Appendix C.*
* There were no baseline values for MW17. Using baseline values from MW18 as a surrogate.

Ta[illegible] 2
Baseline Concentration Values
American Chemical Service NPL Site, Griffith, Indiana

Well Identification	Lower Aquifer															
	MW08	MW09R	MW10C	MW23	MW28	MW29	MW30	MW31	MW32	MW33	MW51	MW52	MW53	MW54R	MW55	MW56
VOCs																
Benzene	10	310	150	10	10	10	10	10	10	10	100	100	10	10	10	NA
Chloroethane	10	2,900	420	10	10	10	10	10	10	10	100	100	10	10	10	NA
Tetrachloroethene	10	200	150	10	10	10	10	10	10	10	100	100	10	10	10	NA
Trichloroethene	10	200	150	10	10	10	10	10	10	10	100	100	10	10	10	NA
1,1-Dichloroethene	10	200	150	10	10	10	10	10	10	10	100	100	10	10	10	NA
1,2-Dichloroethene (*cis* + *trans*)	10	200	150	10	10	10	10	10	10	10	100	100	10	10	10	NA
1,1-Dichloroethane	10	200	150	10	10	10	10	10	10	10	100	100	10	10	10	NA
1,2-Dichloroethane	10	200	150	10	10	10	10	10	10	10	100	100	10	10	10	NA
Vinyl Chloride	10	200	129	10	10	10	10	10	10	10	100	100	10	10	10	NA
SVOCs																
Bis(2-chloroethyl)ether		50														
Metals																
Arsenic																

Notes:
All concentrations in micrograms per liter (ug/L)
Values are from *September 1997 Groundwater Sampling Results Report and Groundwater Monitoring Plan (July 1998), Appendix C.*

F
I
G
U
R
E
S



LEGEND

BARRIER WALL

PERIMETER GROUND WATER CONTAINMENT SYSTEM

MW12 UPPER AQUIFER WELL LOCATION AND DESIGNATION

P61 SG10 PIEZOMETER LOCATION AND DESIGNATION

STAFF GAUGE LOCATION AND DESIGNATION

3 SURFACE DISCHARGE LOCATION FOR PERIMETER GROUND WATER CONTAINMENT SYSTEM

ORCPZ1 ORC PIEZOMETER LOCATION AND DESIGNATION

NOTES:
1. GRAY WELLS INDICATE MEASUREMENT LOCATIONS INCLUDED IN 1998 GROUND WATER MONITORING PLAN.
2. P93 AND P94 DO NOT EXIST, BUT WILL BE REPLACED DURING 2002.
3. SG13 AND SG14 ARE PLANNED FOR INSTALLATION DURING 2002.

N

0 500 1000
SCALE IN FEET

SCALE AS SHOWN

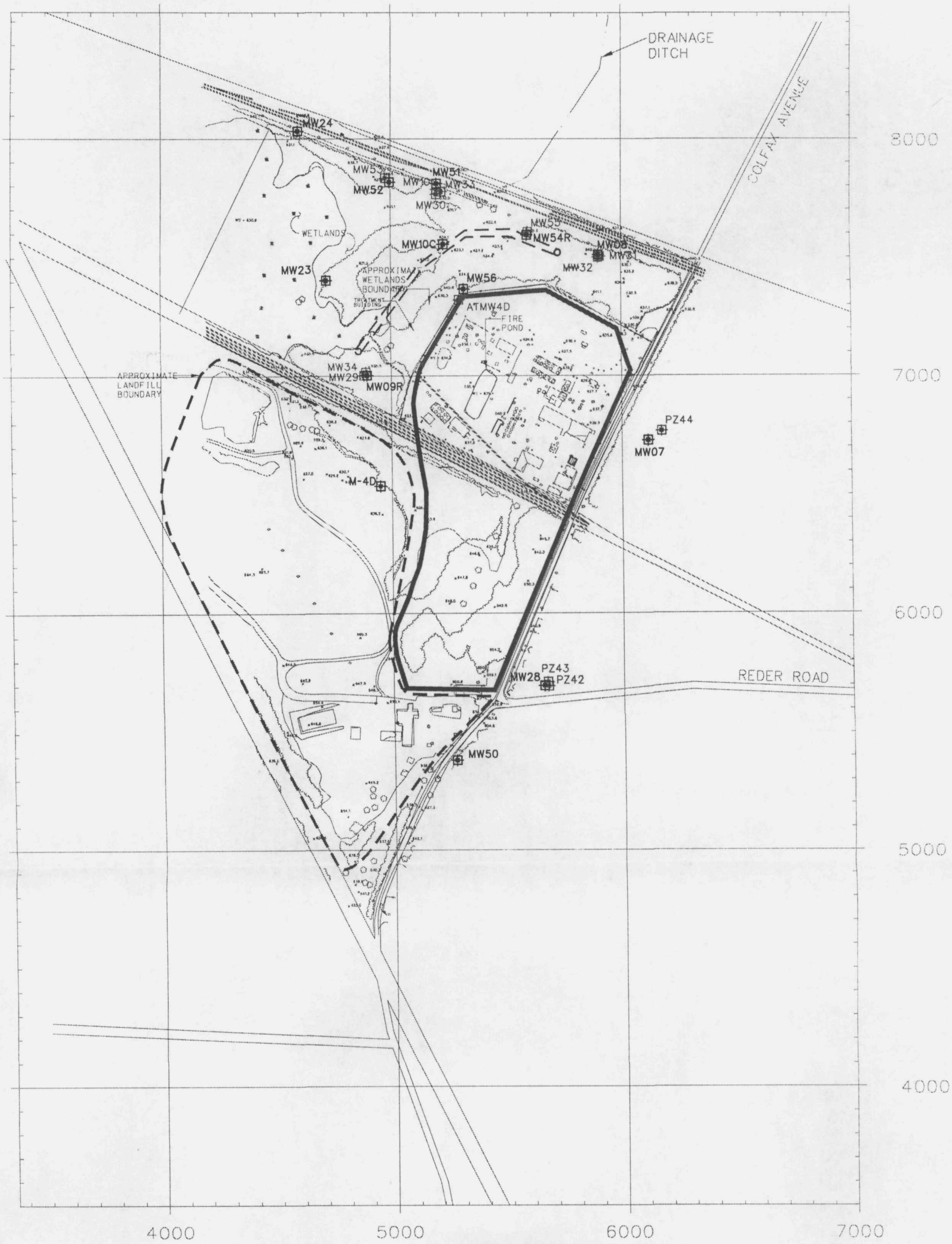
MWH
MONTGOMERY WATSON HARZA

AMERICAN CHEMICAL SERVICES, INC.
NPL SITE
GRIFFITH, INDIANA

LONG-TERM GROUNDWATER MONITORING PLAN UPPER AQUIFER WATER TABLE MEASURMENT LOCATIONS

FIGURE 1

JOB No. 2090603 FILE: J:/209/0603 acs/drawings/LTMP/ua_wla.dgn



LEGEND

BARRIER WALL

PERIMETER GROUND WATER CONTAINMENT SYSTEM

GRIFFITH LANDFILL BOUNDARY

MW53 LOWER AQUIFER WELL LOCATION AND DESIGNATION

NOTES: GRAY WELLS INDICATE MEASUREMENT LOCATION INCLUDED IN 1998 GROUND WATER MONITORING PLAN.

N

0 500 1000

SCALE IN FEET

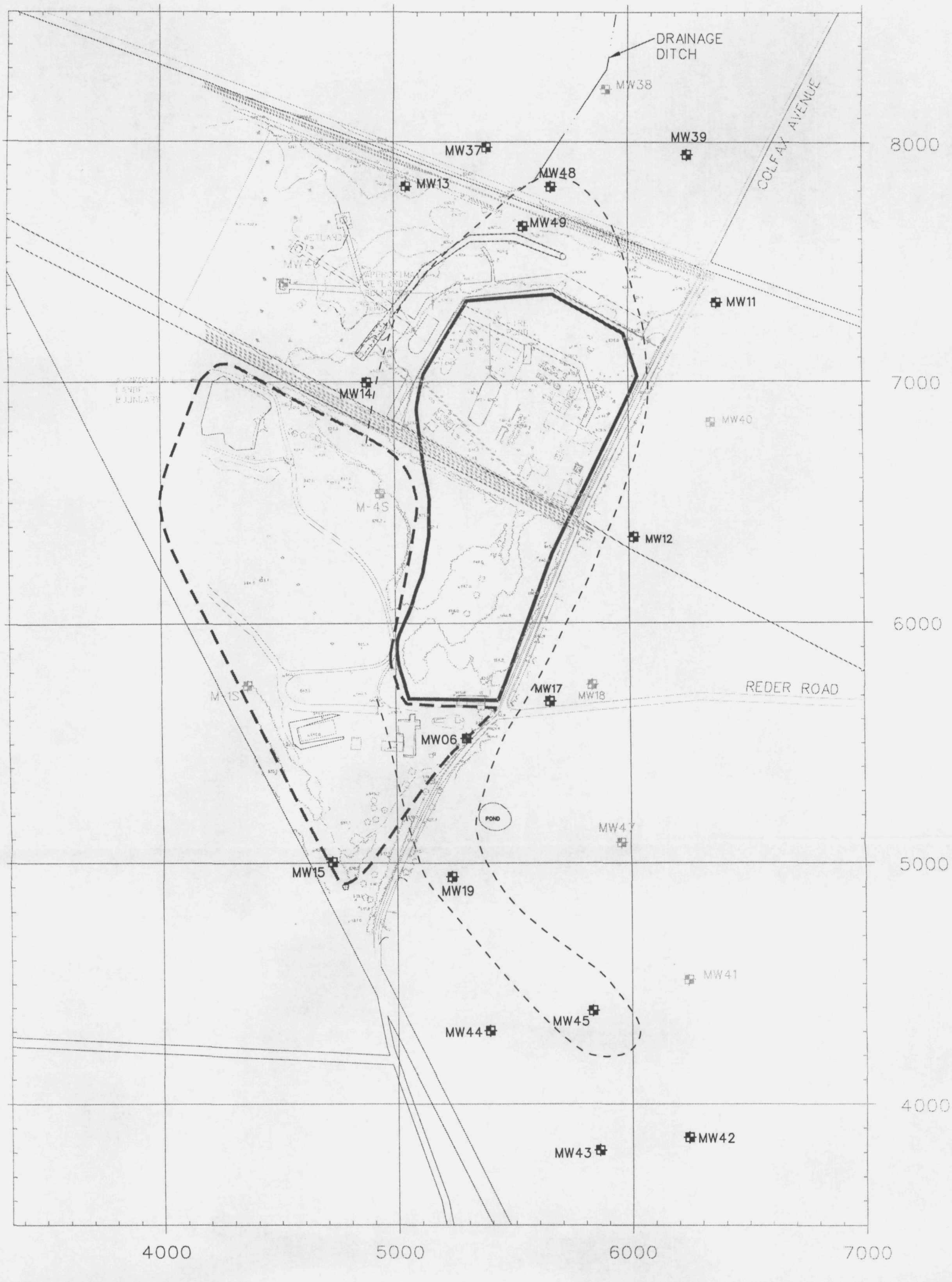
MWH
MONTGOMERY WATSON HARZA

AMERICAN CHEMICAL SERVICES, INC.
NPL SITE
GRIFFITH, INDIANA

LONG-TERM GROUNDWATER
MONITORING PLAN
LOWER AQUIFER POTENTIOMETRIC SURFACE
MEASUREMENT LOCATIONS

FIGURE
2

JOB No. 2090603 FILE: J:/209/0603 acs/drawins/LTMP/la_wlwells.dgn



LEGEND

BARRIER WALL

PERIMETER GROUND WATER CONTAINMENT SYSTEM

MW12 UPPER AQUIFER WELL LOCATION AND DESIGNATION

3 SURFACE DISCHARGE LOCATION FOR PERIMETER GROUND WATER CONTAINMENT SYSTEM

INFERRED EXTENT OF IMPACTED GROUNDWATER

N

0 500 1000
SCALE IN FEET

SCALE
AS SHOWN

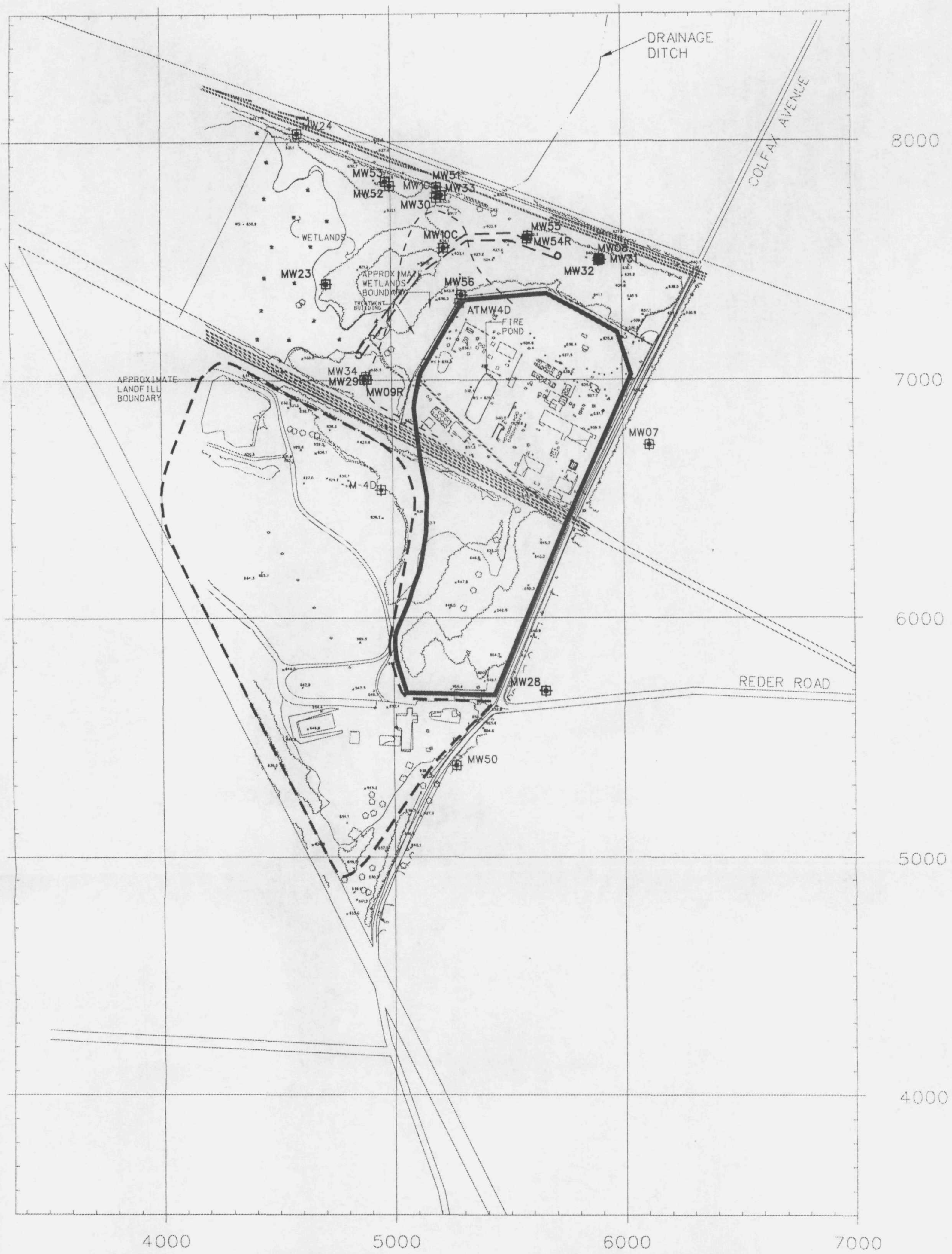
MWH
MONTGOMERY WATSON HARZA

AMERICAN CHEMICAL SERVICES, INC.
NPL SITE
GRIFFITH, INDIANA

LONG-TERM GROUNDWATER
MONITORING PLAN
UPPER AQUIFER SAMPLING LOCATIONS

FIGURE
3

JOB No. 2090603 FILE: J:/209/0603 acs/drawings/LTMP/ua_mpwells.dgn



LEGEND

BARRIER WALL

PERIMETER GROUND WATER CONTAINMENT SYSTEM

GRIFFITH LANDFILL BOUNDARY

MW53 LOWER AQUIFER WELL LOCATION AND DESIGNATION

INFERRED EXTENT OF IMPACTED GROUNDWATER

N

0 500 1000

SCALE IN FEET

SCALE AS SHOWN

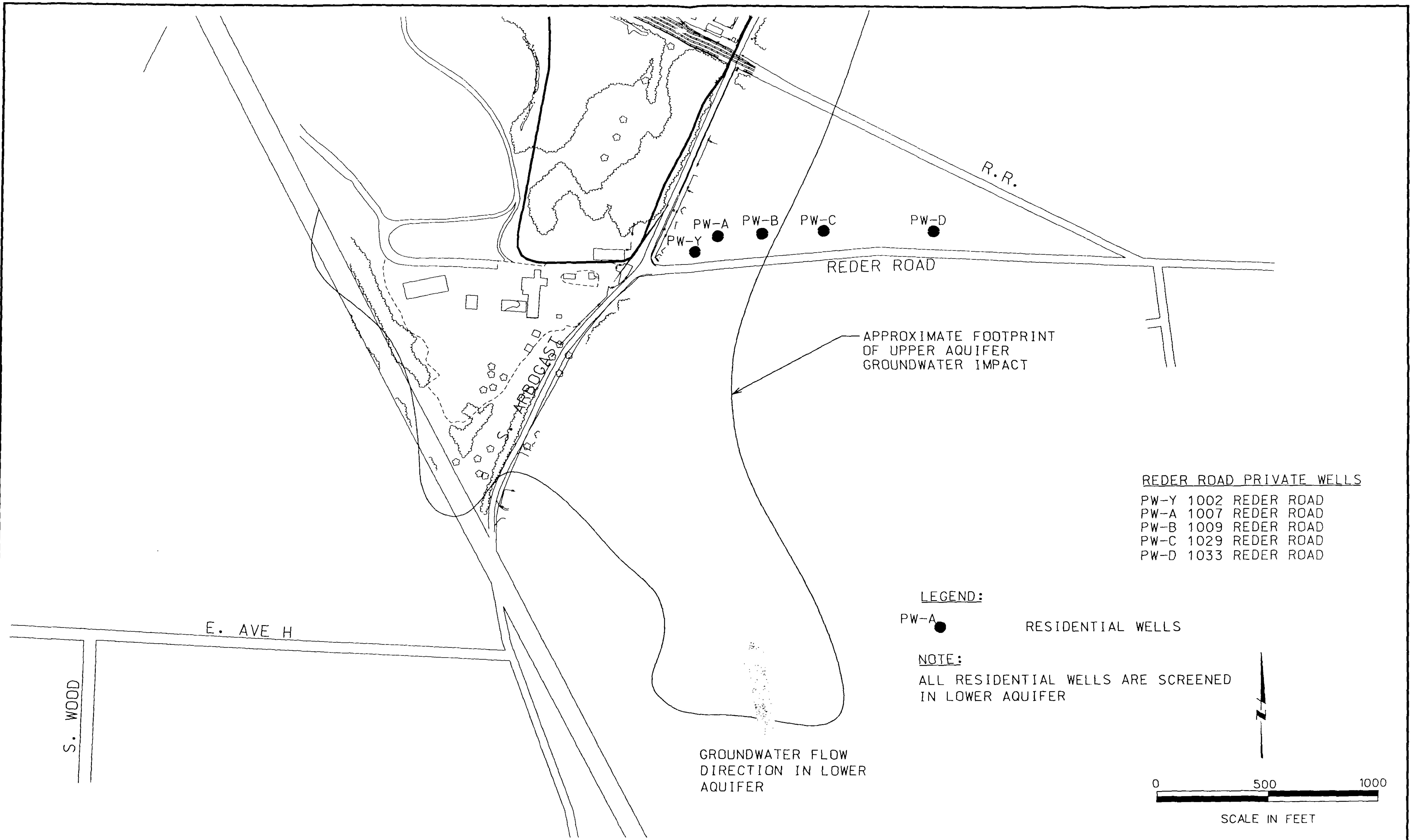
MWH
MONTGOMERY WATSON HARZA

AMERICAN CHEMICAL SERVICES, INC.
NPL SITE
GRIFFITH, INDIANA

LONG-TERM GROUNDWATER MONITORING PLAN
LOWER AQUIFER SAMPLING LOCATIONS

FIGURE 4

JOB No. 2090603 FILE: J:/209/0603 acs/drawins/LTMP/la_mpwells.dgn



SCALE				FIGURE
AS SHOWN	MWH MONTGOMERY WATSON HARZA	AMERICAN CHEMICAL SERVICES, INC. NPL SITE GRIFFITH, INDIANA	RESIDENTIAL WELL LOCATIONS	5

JOB No. MW Job No. FILE: J:/209/0603 acs/drawings/LTMP/RESIDENTIAL_WELL2.dgn

APPENDICES

APPENDIX A

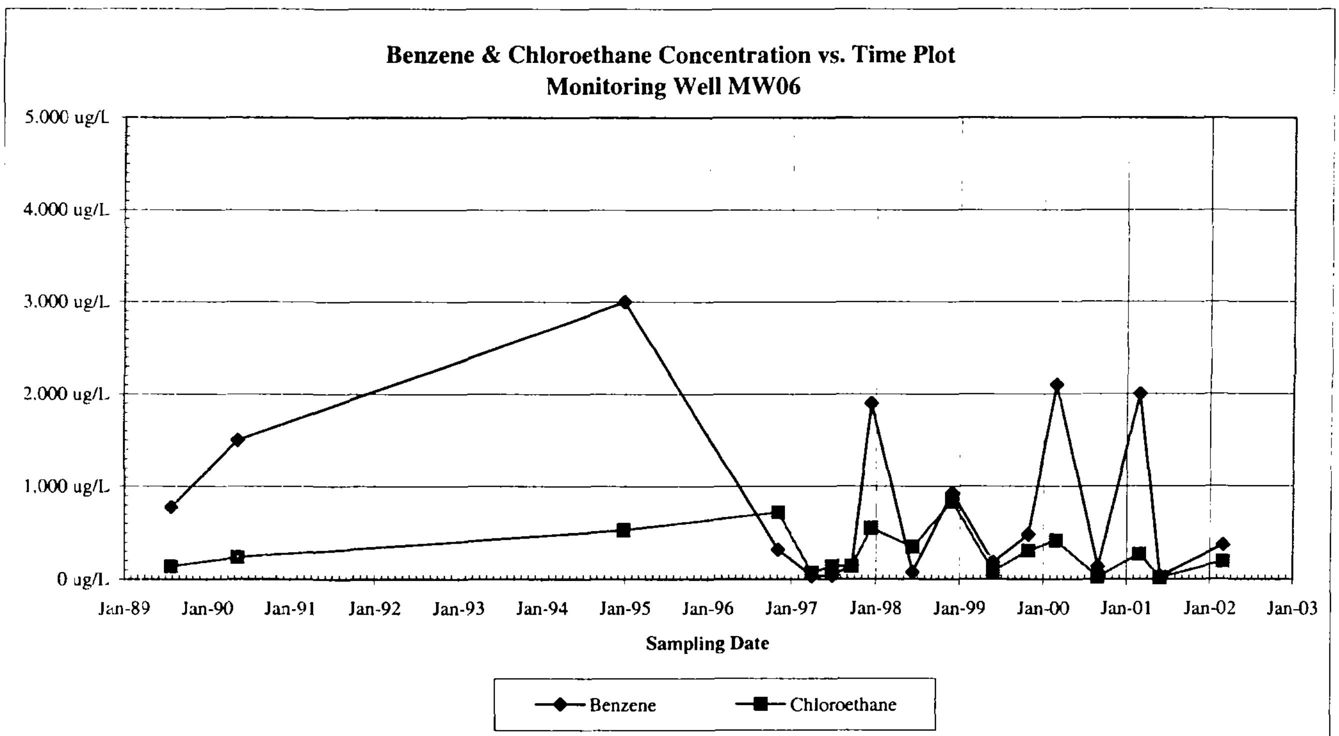
CONCENTRATION-VERSUS-TIME PLOTS

Upper Aquifer
Lower Aquifer

Concentration vs. Time Plot for Upper Aquifer Monitoring Well MW06

Date	Benzene	Chloroethane
BASELINE	**320**	**720**
August-89	780 ug/L	140 ug/L
May-90	1,500 ug/L	240 ug/L
December-94	3,000 ug/L	530 ug/L
November-96	320 ug/L	720 ug/L
April-97	35 ug/L	67 ug/L
July-97	39 ug/L	140 ug/L
September-97	140 ug/L	140 ug/L
December-97	1,900 ug/L	550 ug/L
June-98	72 ug/L	350 ug/L
December-98	930 ug/L	840 ug/L
June-99	180 ug/L	78 ug/L
November-99	480 ug/L	310 ug/L
March-00	2,100 ug/L	420 ug/L
September-00	130 ug/L	22 ug/L
March-01	2,000 ug/L	270 ug/L
June-01	26 ug/L	18 ug/L
March-02	370 ug/L	190 ug/L

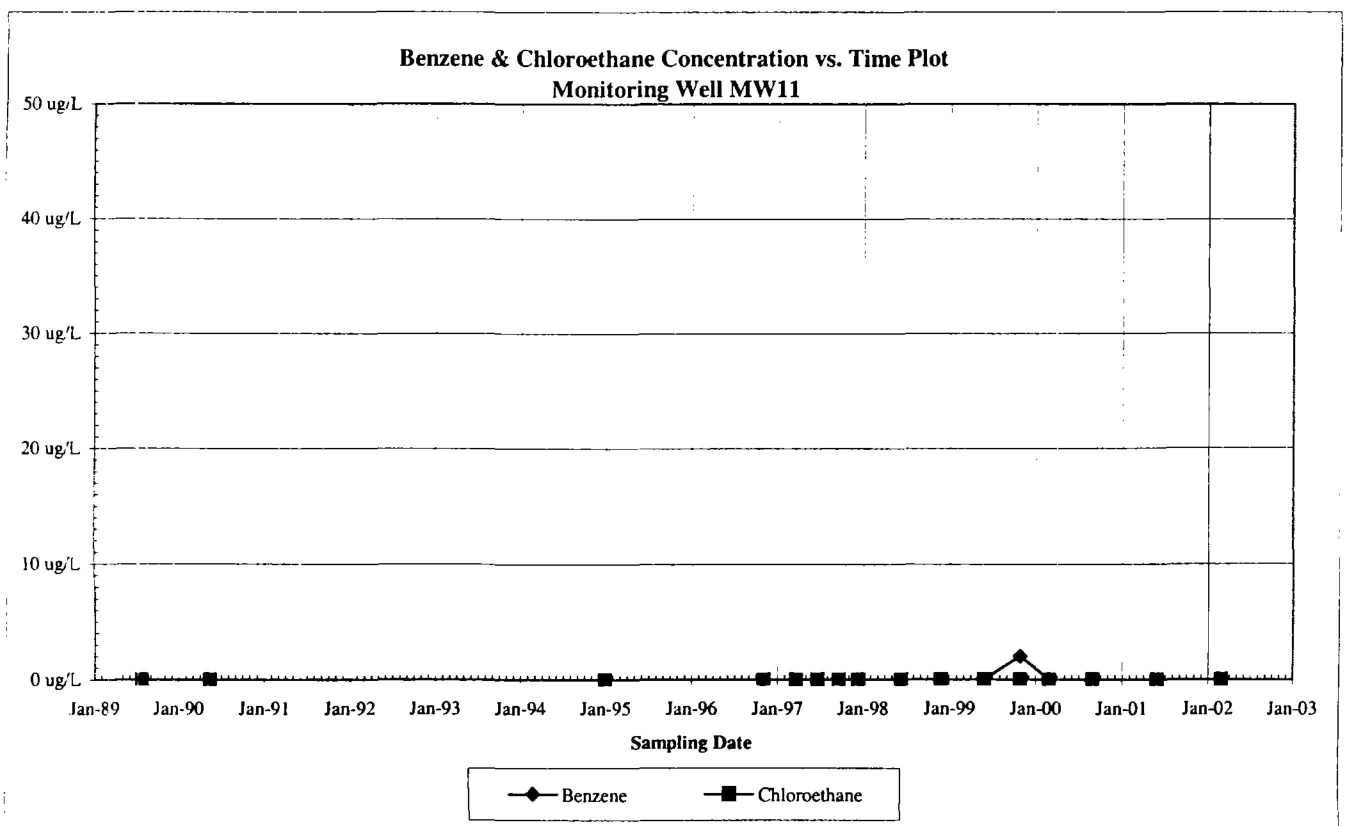
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW11

Date	Benzene	Chloroethane
Baseline	**10**	**10**
August-89	BDL	BDL
May-90	BDL	BDL
January-95	BDL	BDL
November-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	2 ug/L	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

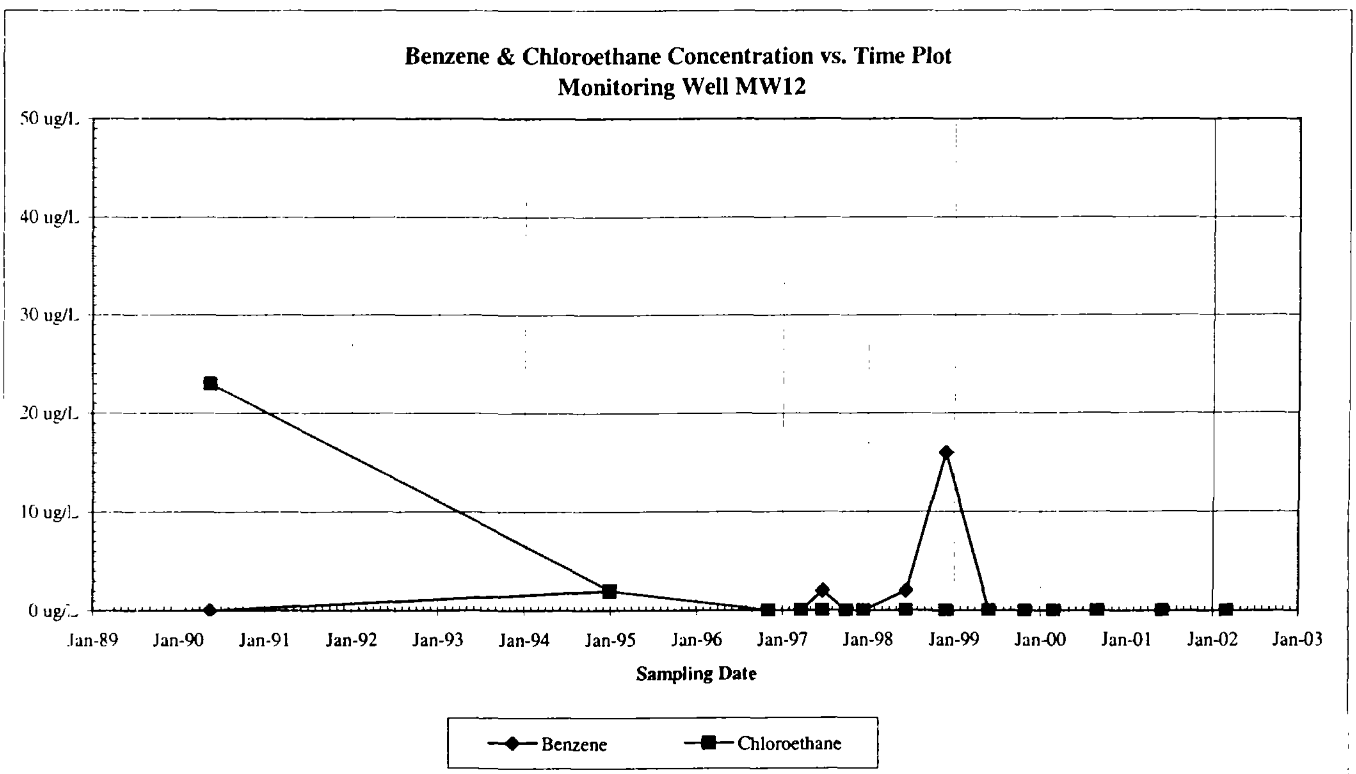
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW12

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90	BDL	23 ug/L
January-95	2 ug/L	2 ug/L
November-96	BDL	BDL
March-97	BDL	BDL
June-97	2 ug/L	BDL
October-97	BDL	BDL
December-97	BDL	BDL
June-98	2 ug/L	BDL
December-98	16 ug/L	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

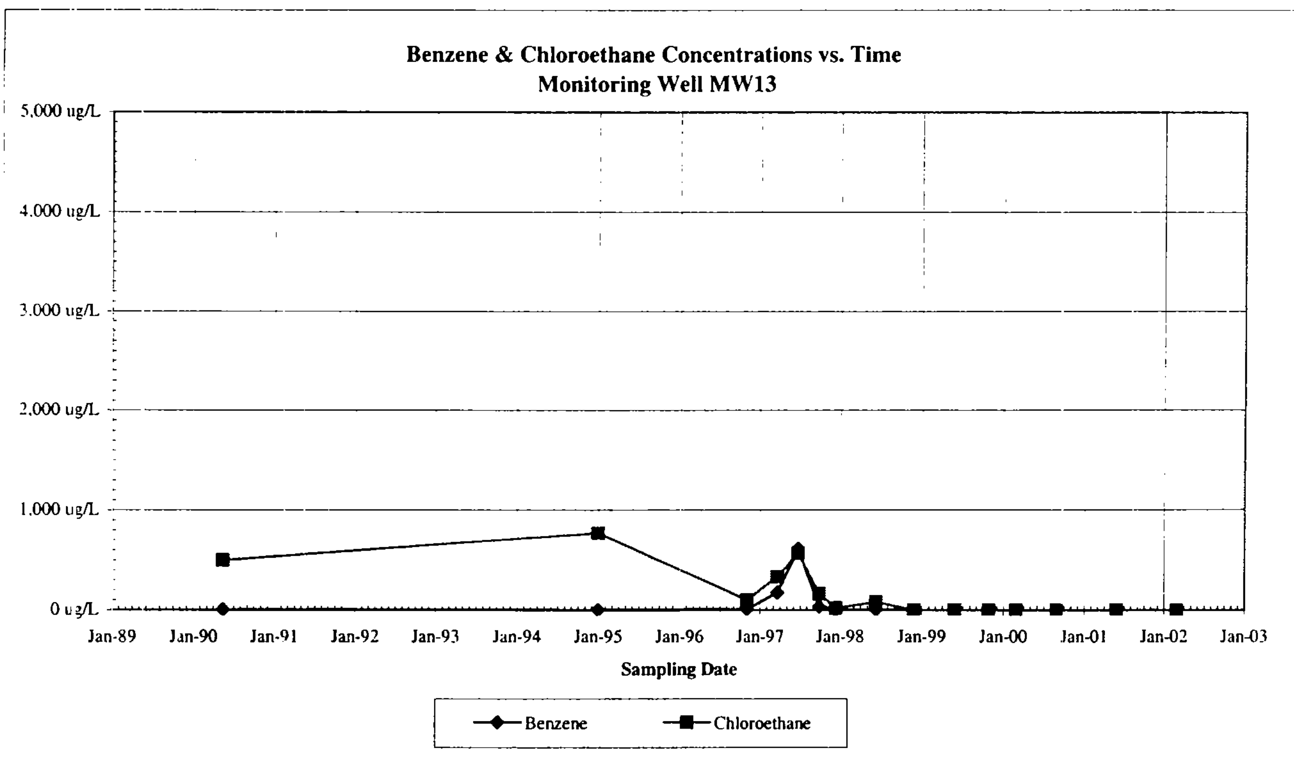
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW13

Date	Benzene	Chloroethane
Baseline	**610**	**570**
August-89		
May-90	2 ug/L	500 ug/L
January-95	BDL	770 ug/L
November-96	6 ug/L	97 ug/L
March-97	170 ug/L	330 ug/L
June-97	610 ug/L	570 ug/L
October-97	33 ug/L	160 ug/L
December-97	BDL	20 ug/L
June-98	2 ug/L	82 ug/L
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

BDL = Below the Detection Limit



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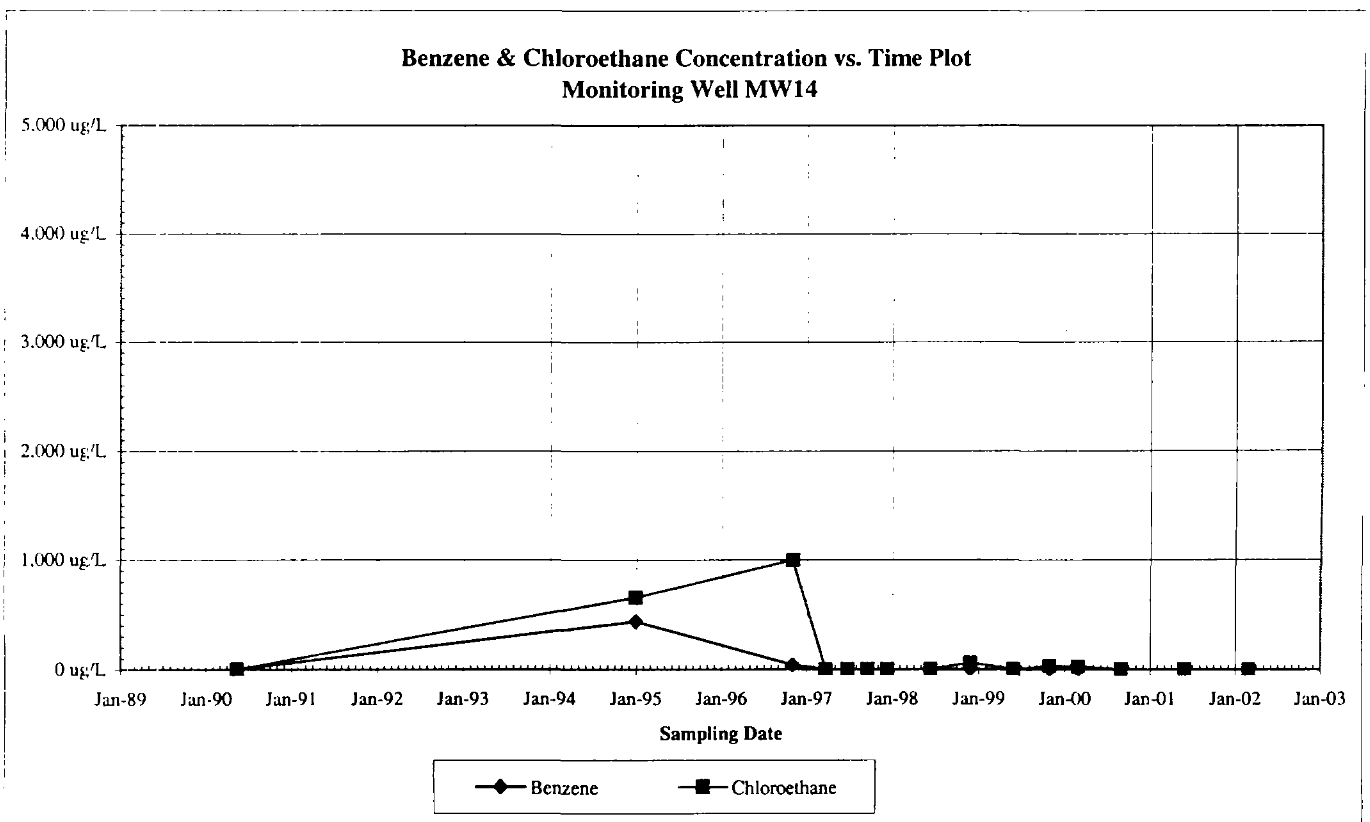
J:209\0603 ACS\Database\Timetrnd_GWMP_UA.xls[MW13] 9/4/2002

Concentration vs. Time Plot for Upper Aquifer Monitoring Well MW14

Date	Benzene	Chloroethane
Baseline	**41**	**1000**
August-89		
May-90	2 ug/L	3 ug/L
January-95	440 ug/L	660 ug/L
November-96	41 ug/L	1,000 ug/L
March-97	BDL	BDL
June-97	1 ug/L	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	59 ug/L
June-99	BDL	BDL
November-99	2 ug/L	32 ug/L
March-00	2 ug/L	26 ug/L
September-00	BDL	BDL
June-01	BDL	BDL
March-02	1 ug/L	BDL

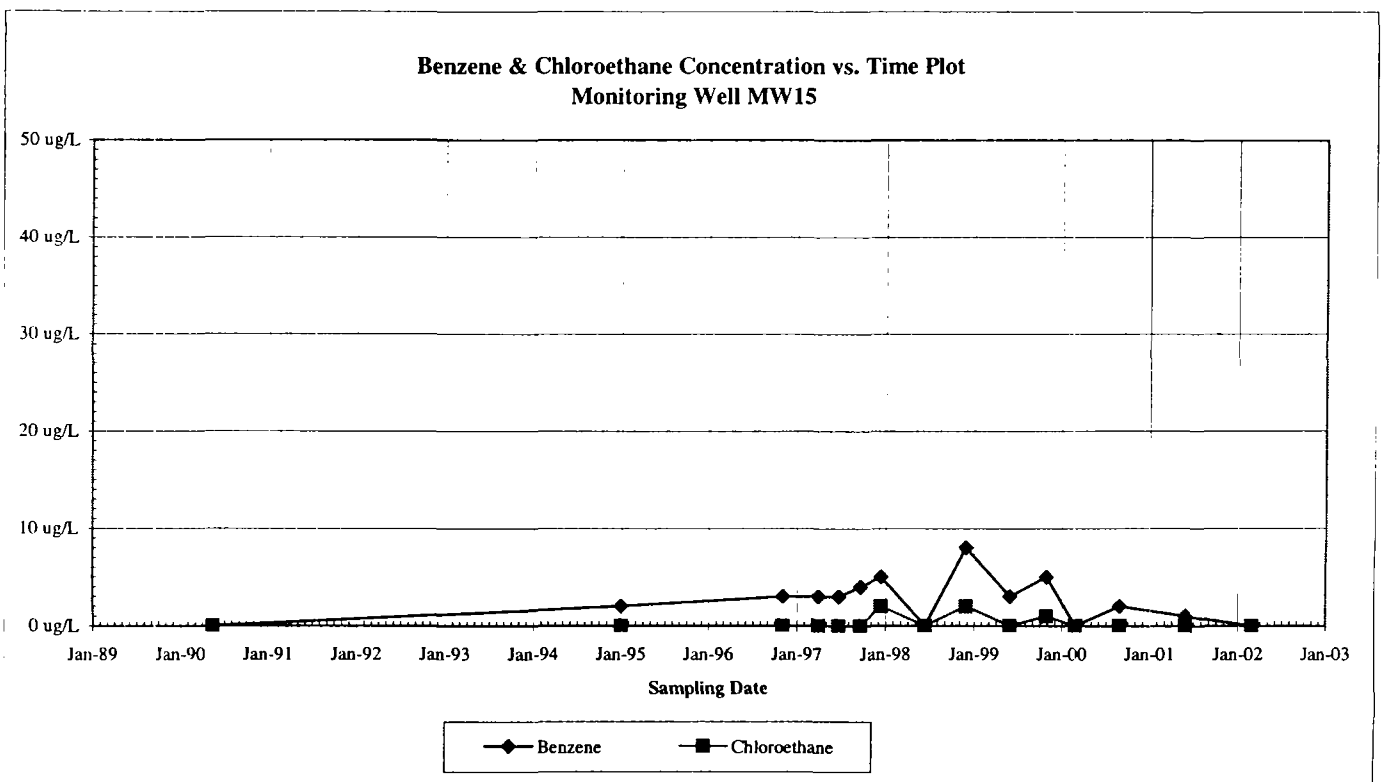
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW15

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90	BDL	BDL
January-95	2 ug/L	BDL
November-96	3 ug/L	BDL
April-97	3 ug/L	BDL
June-97	3 ug/L	BDL
September-97	4 ug/L	BDL
December-97	5 ug/L	2 ug/L
June-98	BDL	BDL
December-98	8 ug/L	2 ug/L
June-99	3 ug/L	BDL
November-99	5 ug/L	1 ug/L
March-00	BDL	BDL
September-00	2	BDL
June-01	1	BDL
March-02	BDL	BDL

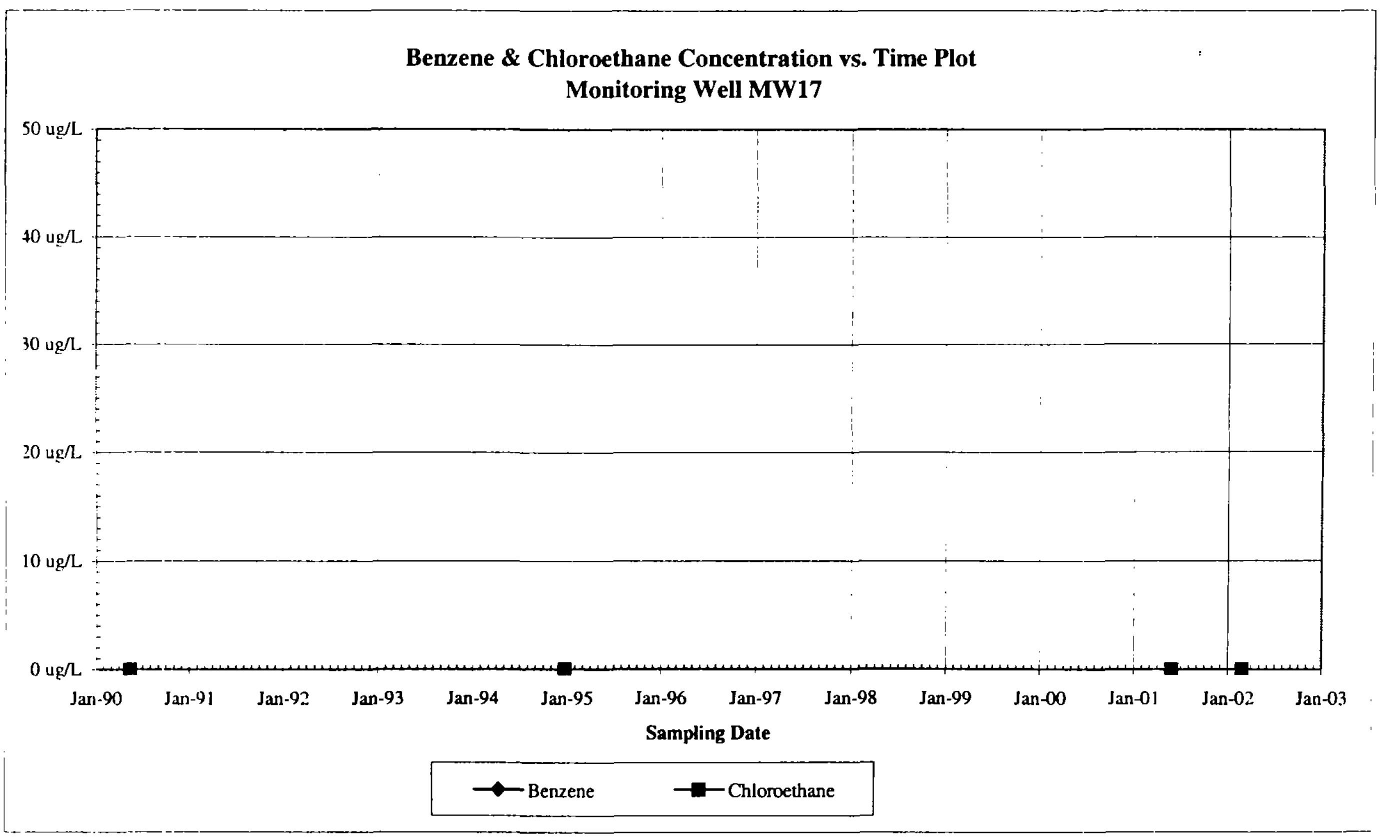
BDL = Below the Detection Limit



Concentration vs. Time Plot for Upper Aquifer Monitoring Well MW17

Date	Benzene	Chloroethane
BASELINE	NA	NA
May-90	BDL	BDL
December-94	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

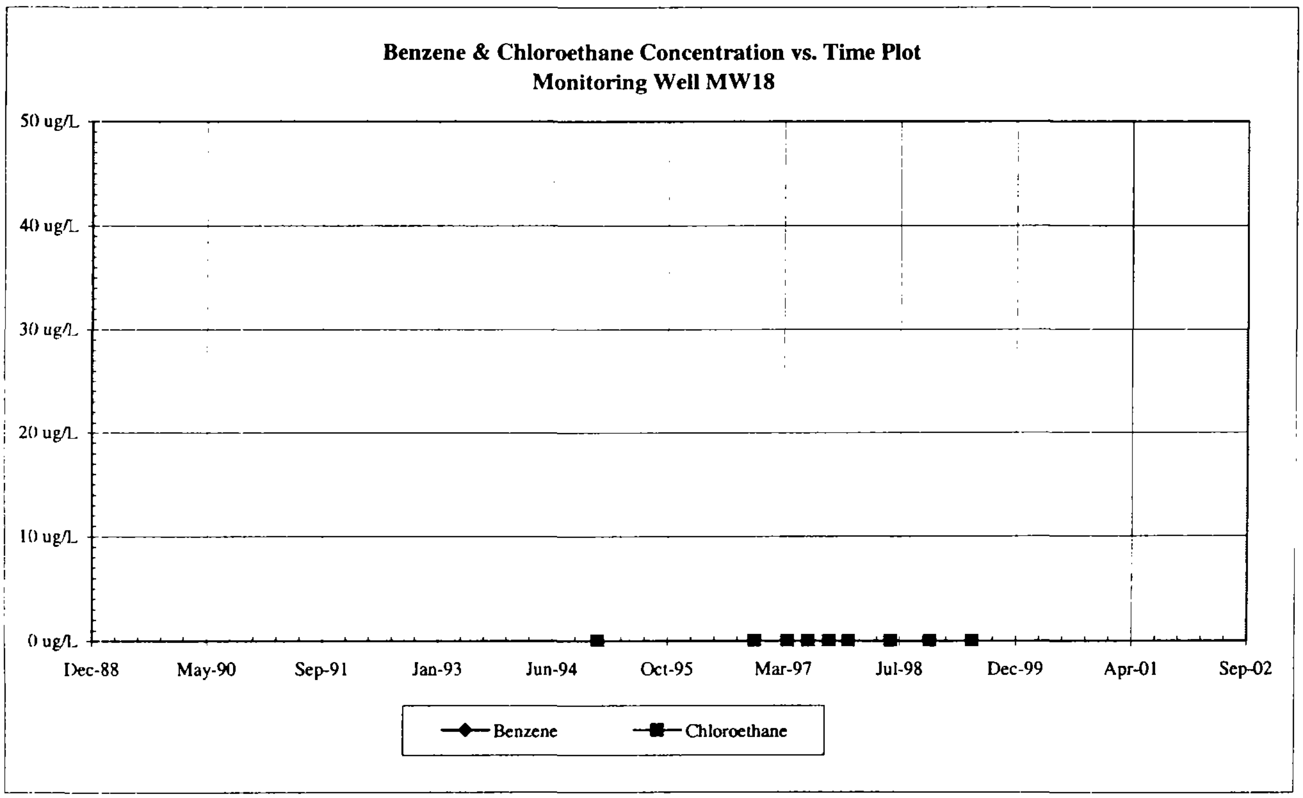
BDL = Below the Detection Limit
NA = No baseline conducted on this well.



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well: MW18

Date	Benzene	Chloroethane	
BASELINE	**10**	**10**	
August-89			
May-90			
December-94	BDL	BDL	
November-96	BDL	BDL	
March-97	BDL	BDL	
June-97	BDL	BDL	
September-97	BDL	BDL	
December-97	BDL	BDL	
June-98	BDL	BDL	
December-98	BDL	BDL	
June-99	BDL	BDL	
November-99			Not Sampled - Dry
March-00			Not Sampled - Dry
September-01			Not Sampled - Dry
June-01			Not Sampled - Dry

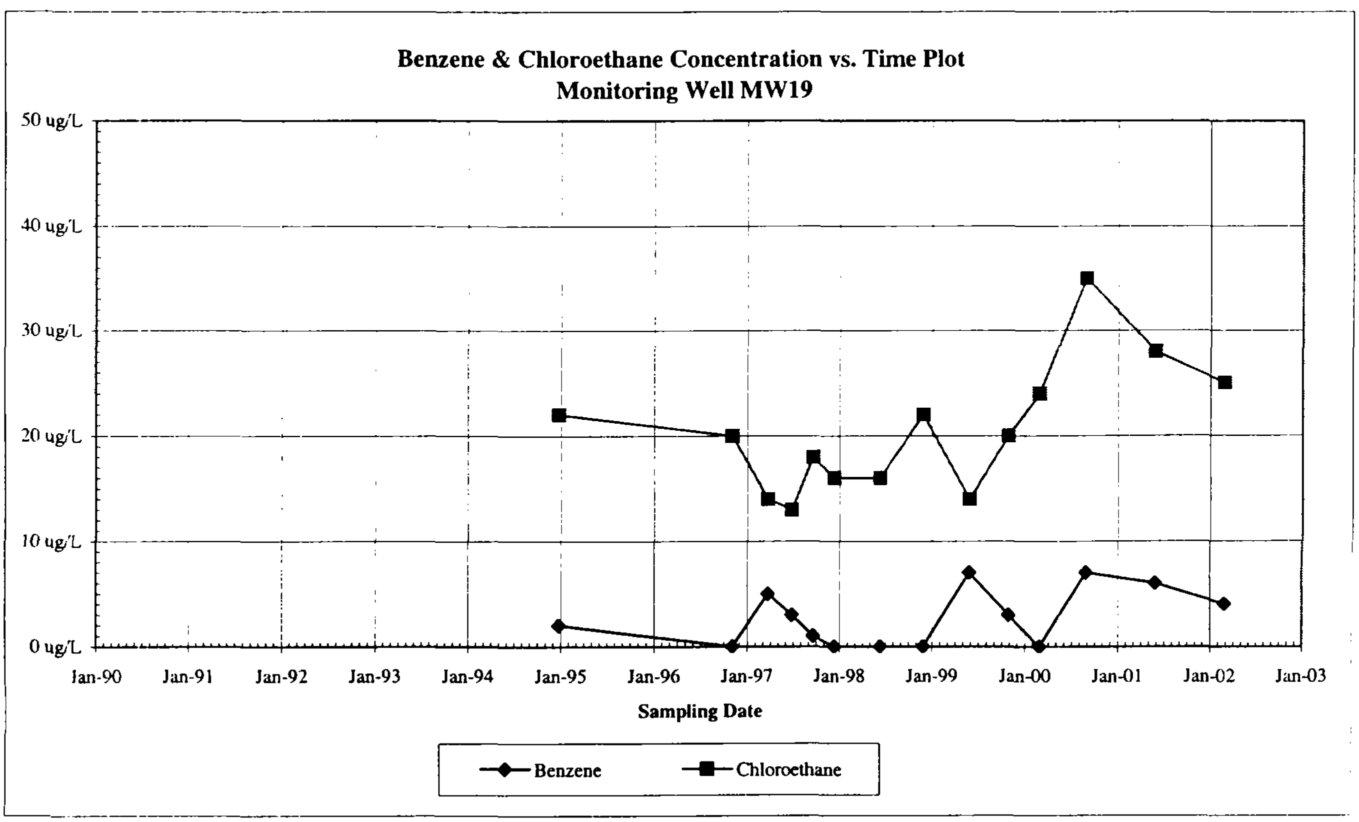
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW19

Date	Benzene	Chloroethane
BASELINE	**10**	**20**
August-89		
May-90		
December-94	2 ug/L	22 ug/L
November-96	BDL	20 ug/L
March-97	5 ug/L	14 ug/L
June-97	3 ug/L	13 ug/L
September-97	1 ug/L	18 ug/L
December-97	BDL	16 ug/L
June-98	BDL	16 ug/L
December-98	BDL	22 ug/L
June-99	7 ug/L	14 ug/L
November-99	3 ug/L	20 ug/L
March-00	BDL	24 ug/L
September-00	7	35 ug/L
June-01	6	28 ug/L
March-02	4	25 ug/L

BDL = Below the Detection Limit



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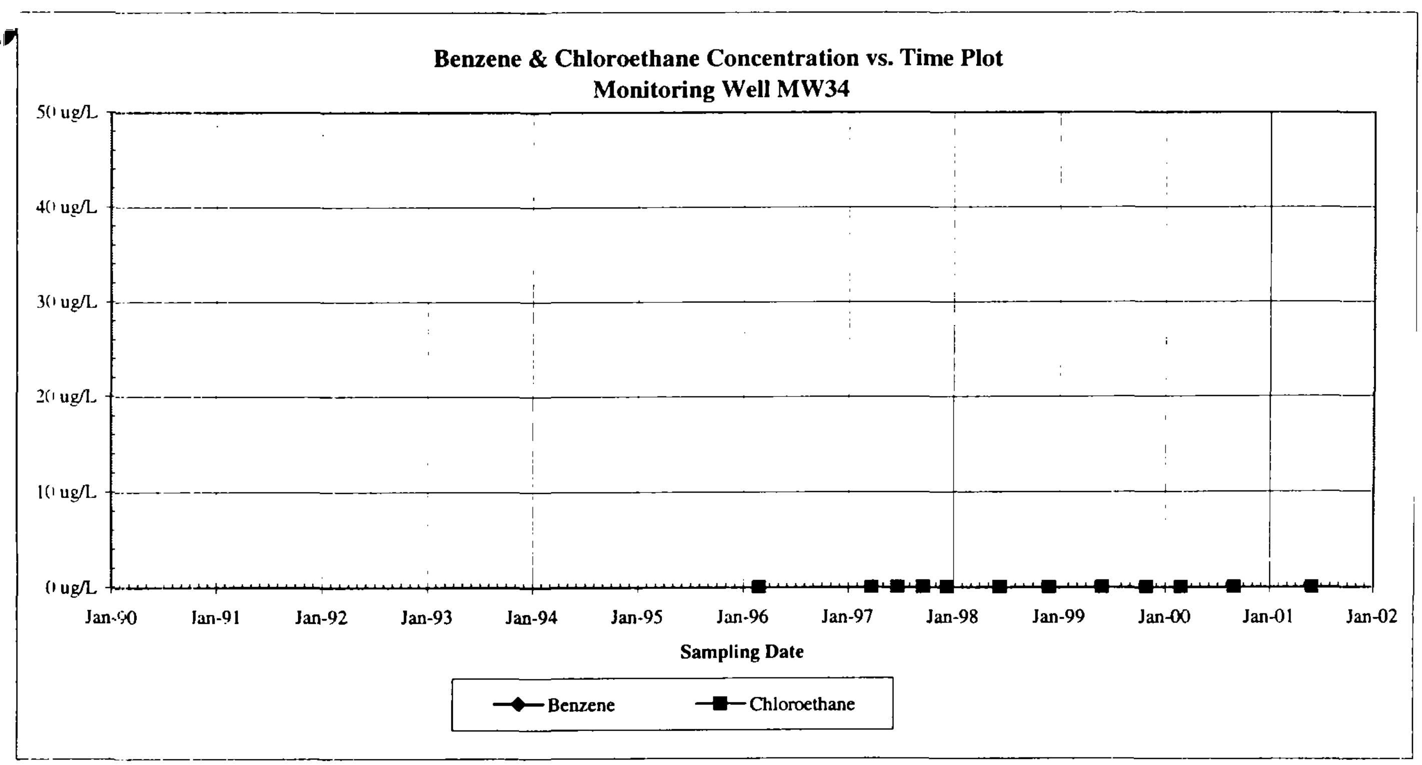
Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW34

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
January-95		
March-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL

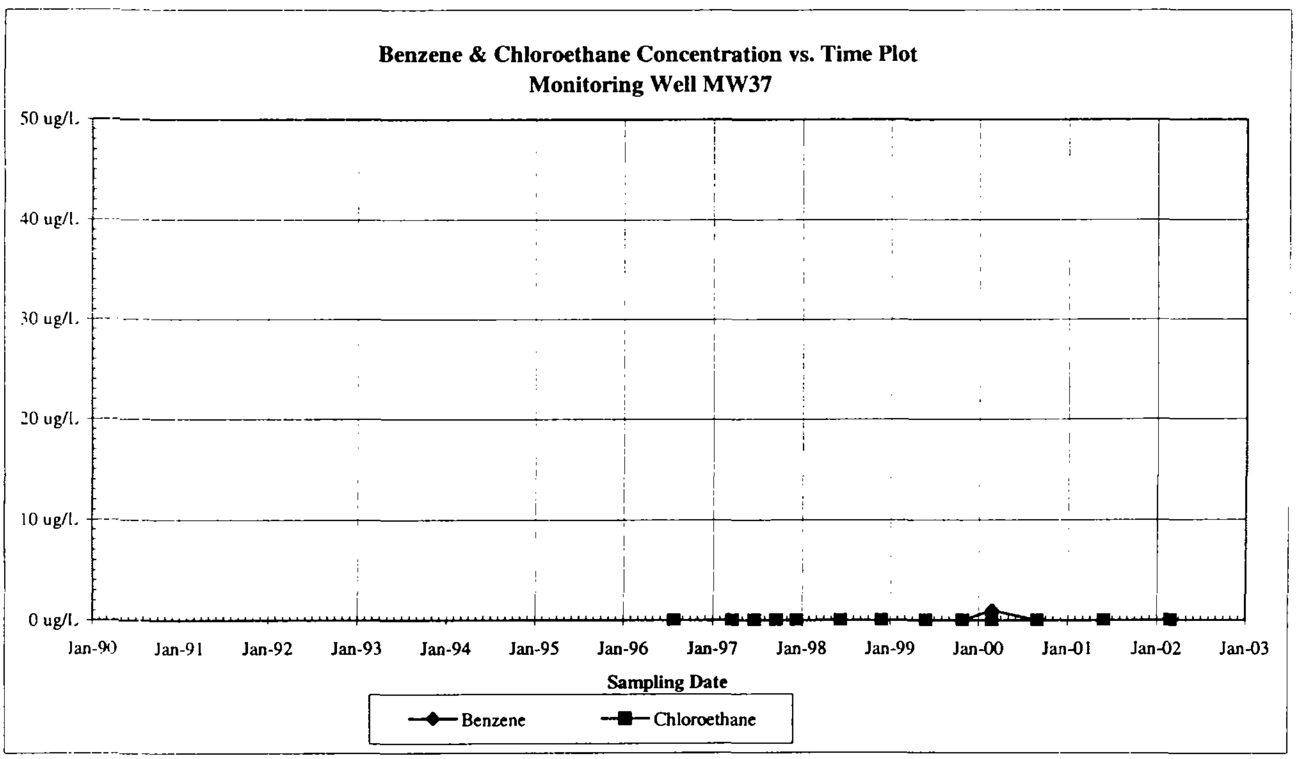
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW37

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
December-94		
August-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	1 ug/L	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

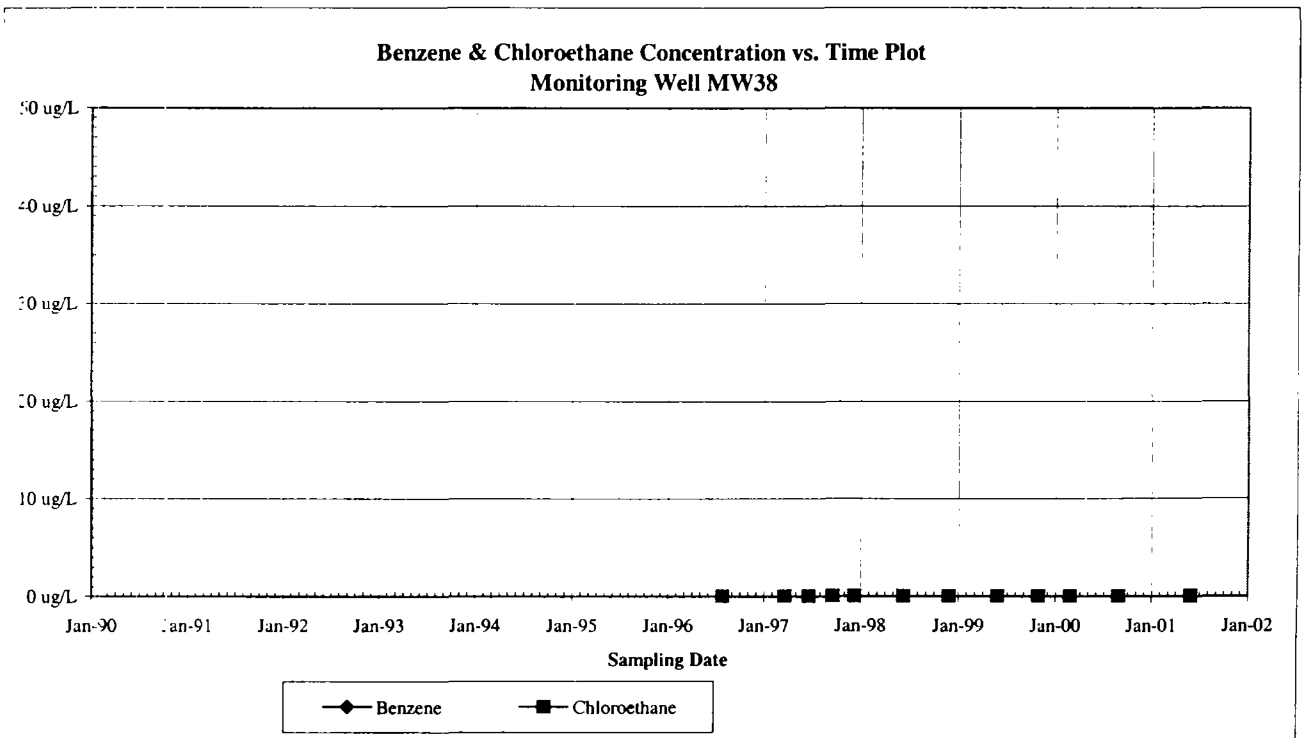
BDL = Below the Detection Limit



Concentration vs. Time for
Upper Aquifer Monitoring Well: MW38

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
December-94		
August-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL

BDL = Below the Detection Limit



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J:20900603 ACS\Database\Timetrnd_IMPwells.xls[MW38]

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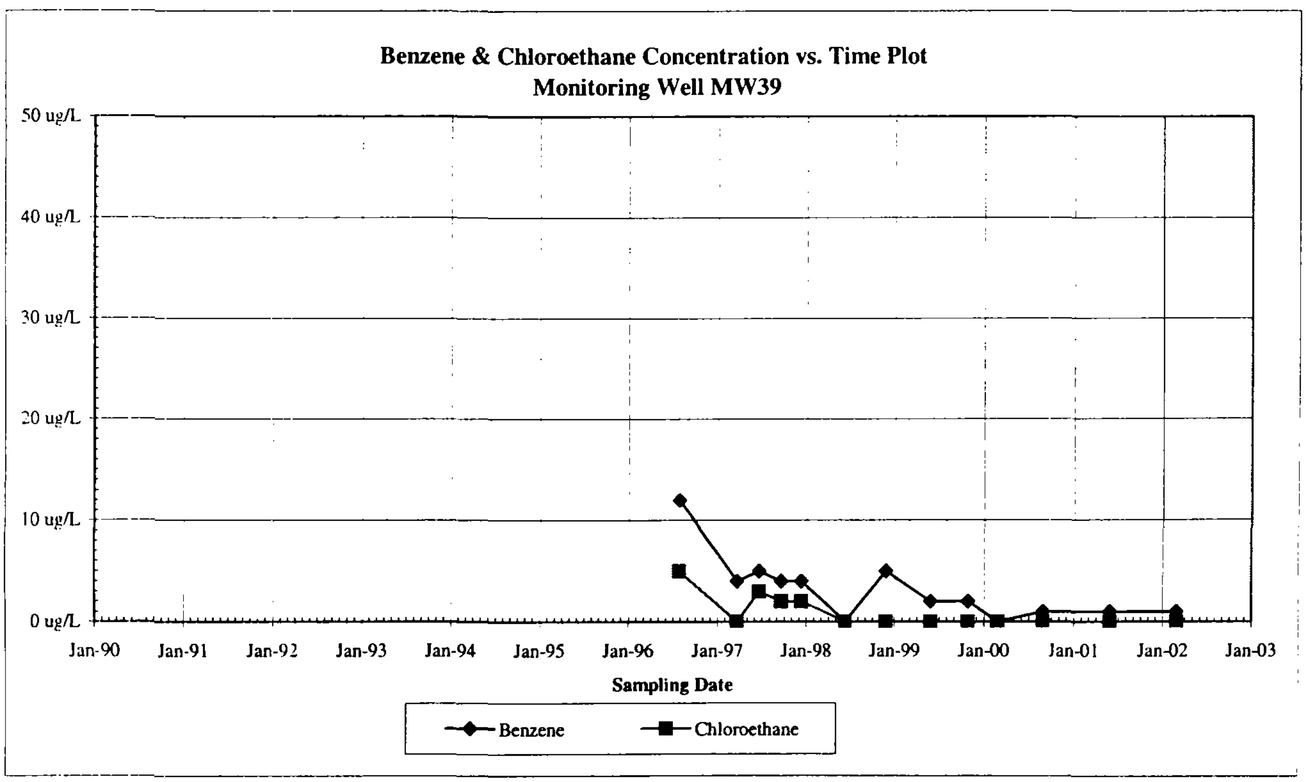
Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW39

Date	Benzene	Chloroethane
BASELINE	12	10
August-89		
May-90		
December-94		
August-96	12 ug/L	5 ug/L
March-97	4 ug/L	BDL
June-97	5 ug/L	3 ug/L
September-97	4 ug/L	2 ug/L
December-97	4 ug/L	2 ug/L
June-98	BDL	BDL
December-98	5 ug/L	BDL
June-99	2 ug/L	BDL
November-99	2 ug/L	BDL
March-00	BDL	BDL
September-00	1 ug/L	BDL
June-01	1 ug/L	BDL
March-02	1 ug/L	BDL

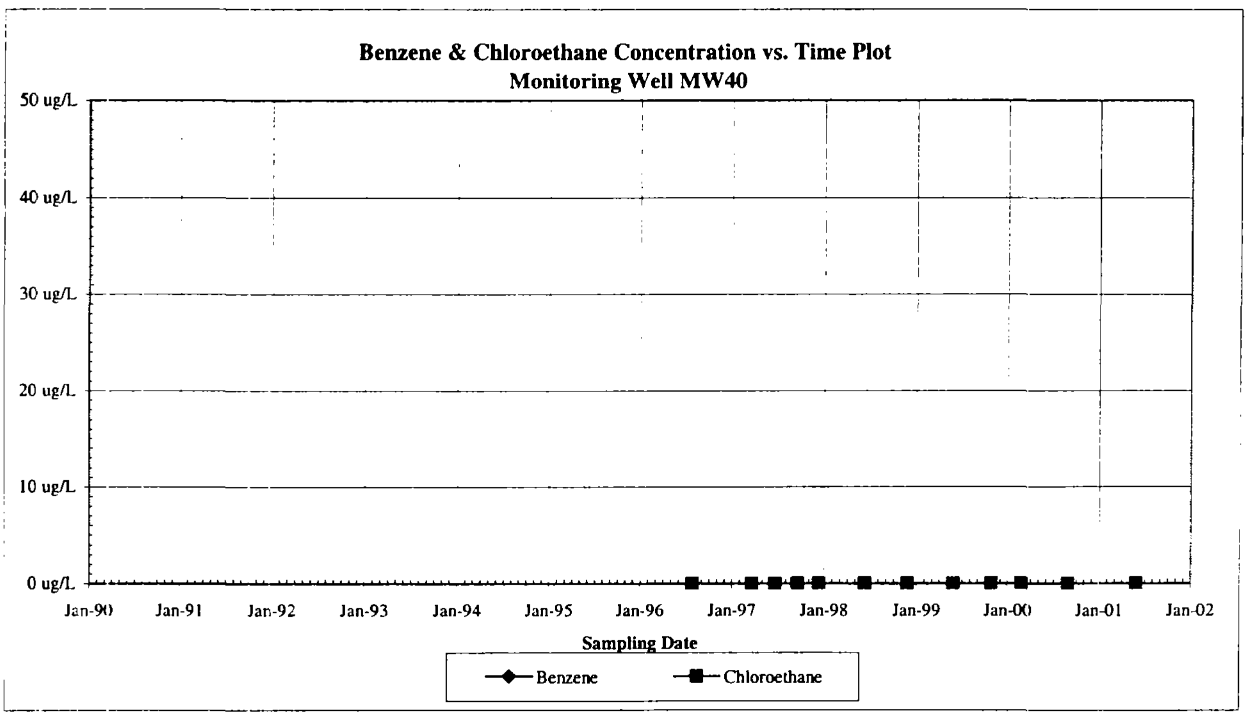
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well: MW40

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
December-94		
August-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL

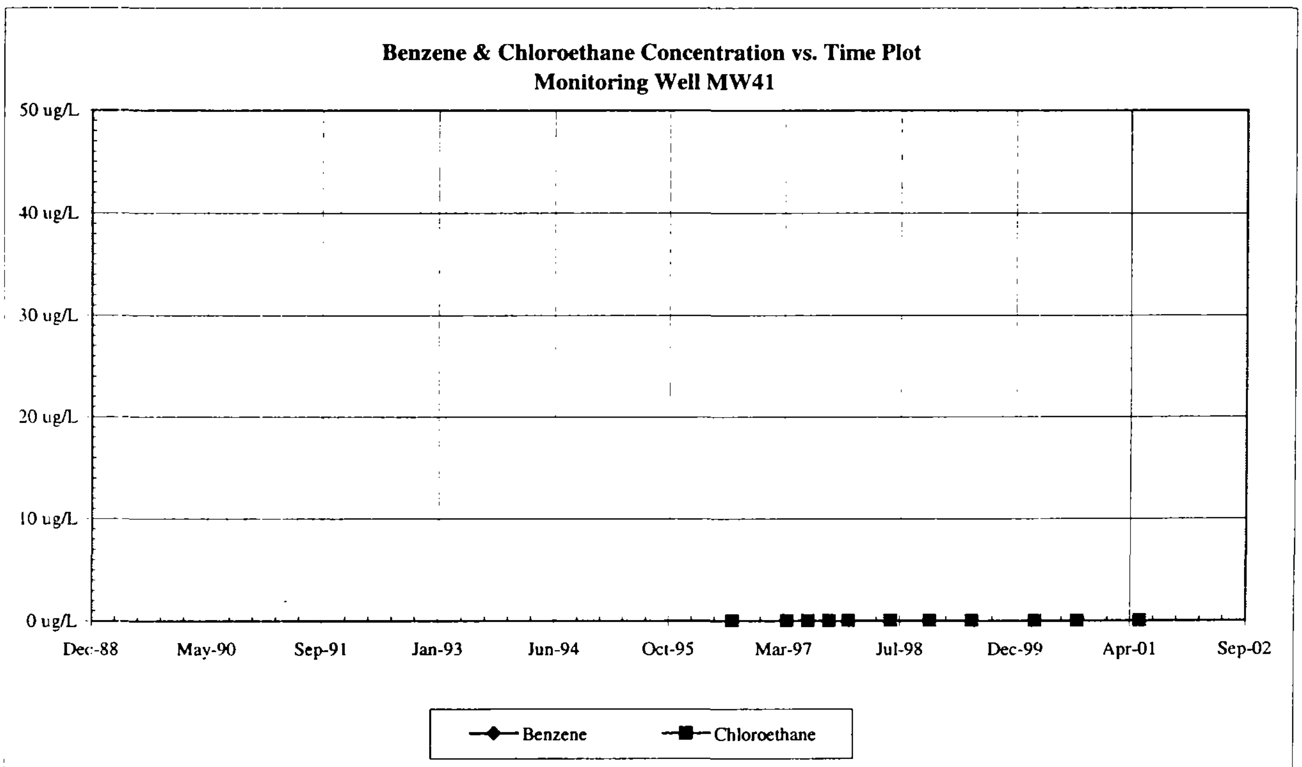
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well: MW41

Date	Benzene	Chloroethane	
BASELINE	10	10	
August-89			
May-90			
December-94			
August-96	BDL	BDL	
March-97	BDL	BDL	
June-97	BDL	BDL	
September-97	BDL	BDL	
December-97	BDL	BDL	
June-98	BDL	BDL	
December-98	BDL	BDL	
June-99	BDL	BDL	
November-99			Not Sampled - Dry
March-00	BDL	BDL	
September-00	BDL	BDL	
June-01	BDL	BDL	

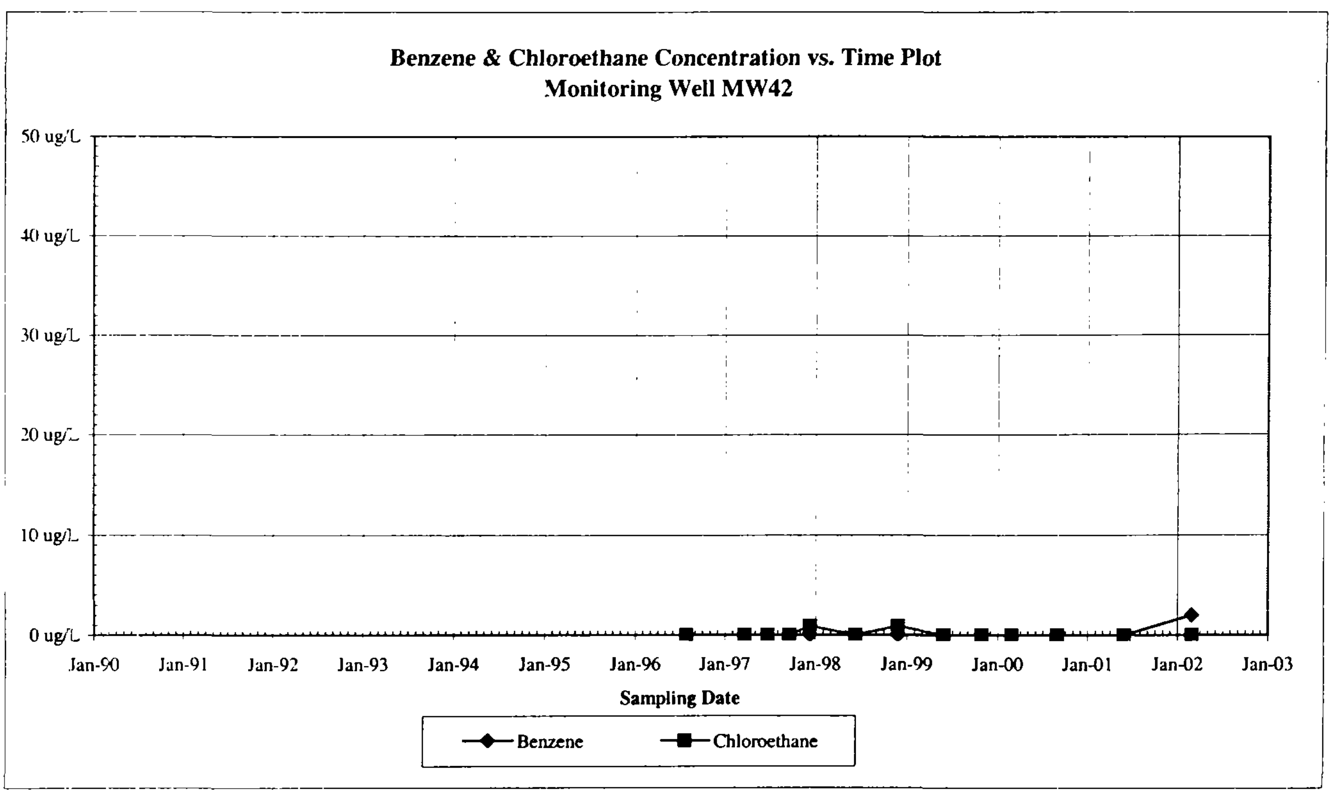
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW42

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
December-94		
August-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	0.9 ug/L
June-98	BDL	BDL
December-98	BDL	0.9 ug/L
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	2	BDL

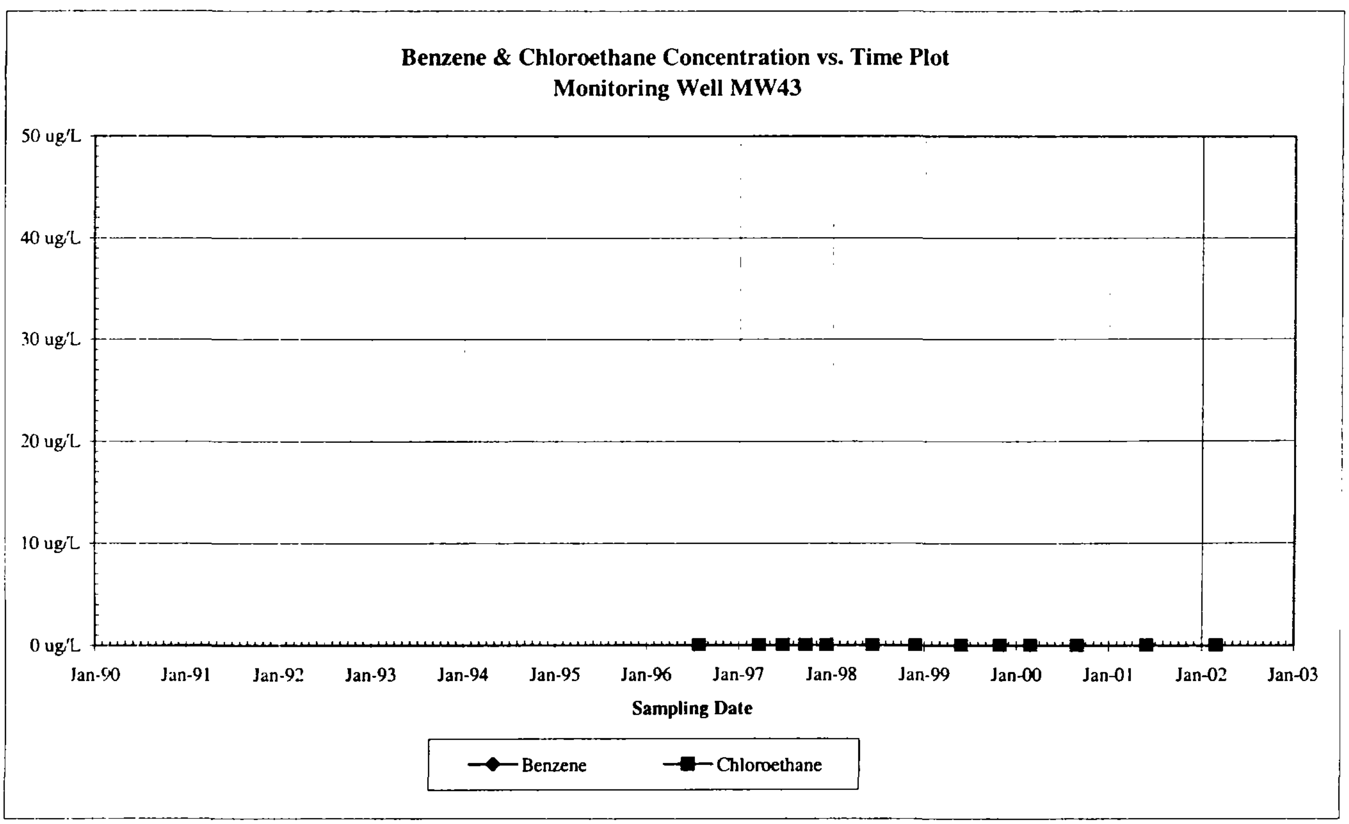
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW43

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
December-94		
August-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

BDL = Below the Detection Limit



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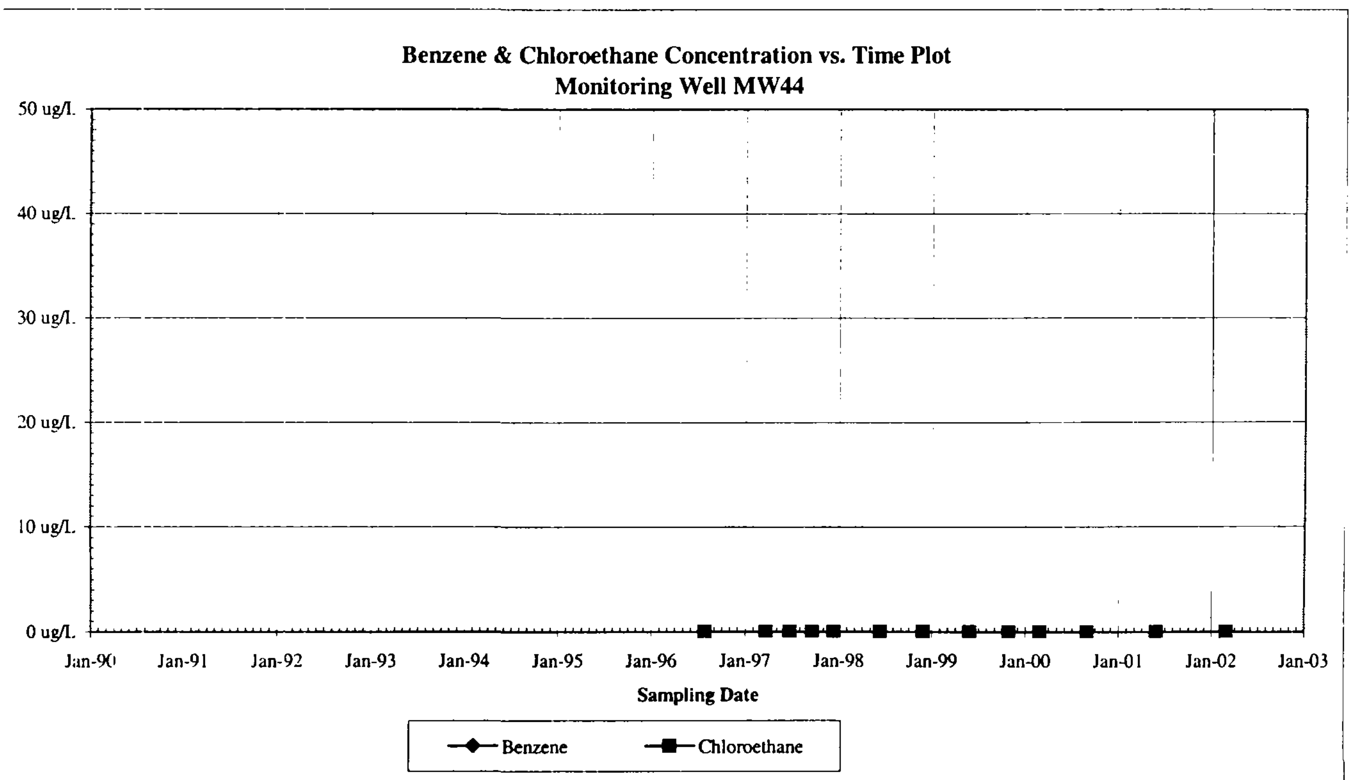
9/4/2002

Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW44

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
December-94		
August-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

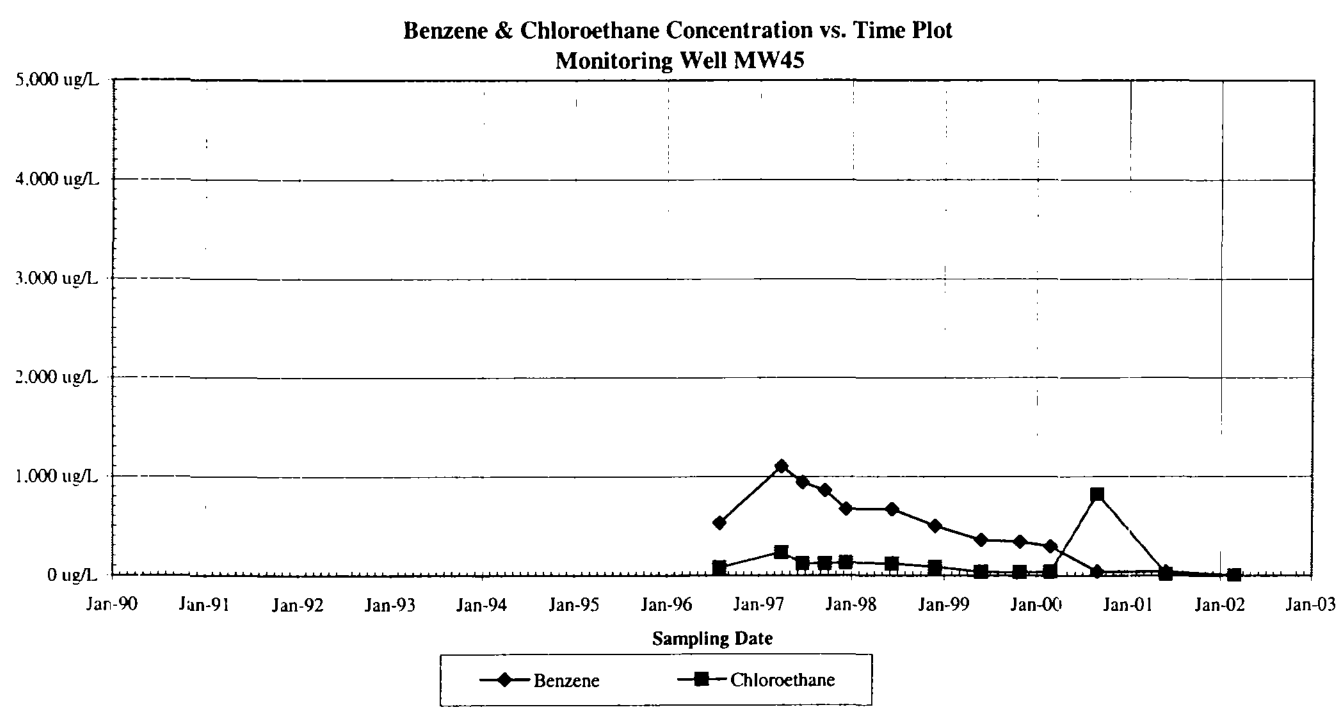
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW45

Date	Benzene	Chloroethane
BASELINE	**1045**	**215**
August-89		
May-90		
December-94		
August-96	530 ug/L	82 ug/L
April-97	1,100 ug/L	230 ug/L
June-97	940 ug/L	120 ug/L
September-97	860 ug/L	120 ug/L
December-97	670 ug/L	130 ug/L
June-98	670 ug/L	120 ug/L
December-98	500 ug/L	88 ug/L
June-99	360 ug/L	38 ug/L
November-99	340 ug/L	32 ug/L
March-00	290 ug/L	38 ug/L
September-00	43 ug/L	820 ug/L
June-01	39 ug/L	17 ug/L
March-02	3 ug/L	4 ug/L

BDL = Below the Detection Limit



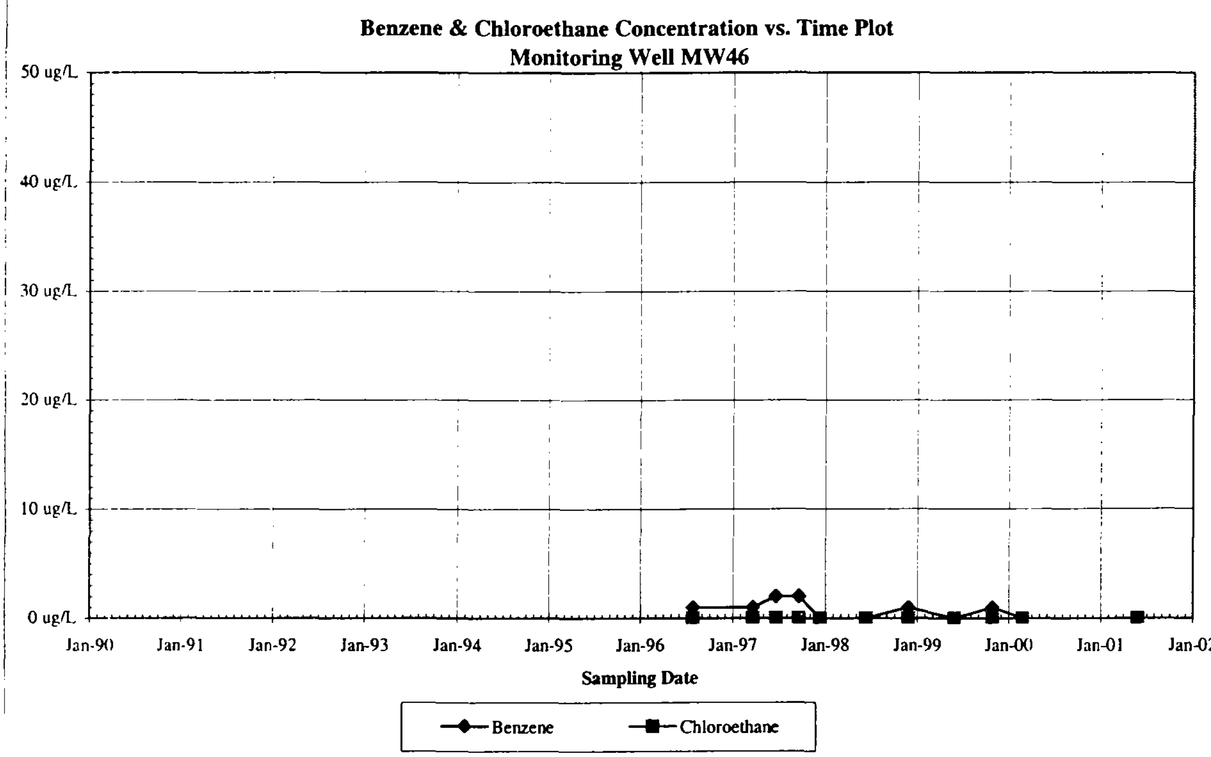
JMK/JMS/CAS
J:209\0603 ACS\Database\Timetrnd_GWMP_UA.xls[MW45]

9/4/2002

Concentration vs. Time Plot for
Upper Aquifer Monitoring Well: MW46

Date	Benzene	Chloroethane	
BASELINE	10	10	
August-89			
May-90			
December-94			
August-96	1 ug/L	BDL	
March-97	1 ug/L	BDL	
June-97	2 ug/L	BDL	
September-97	2 ug/L	BDL	
December-97	BDL	BDL	
June-98	BDL	BDL	
December-98	1 ug/L	BDL	
June-99	BDL	BDL	
November-99	1 ug/L	BDL	
March-00	BDL	BDL	
September-00			Not sampled - could not be found
June-01	BDL	BDL	

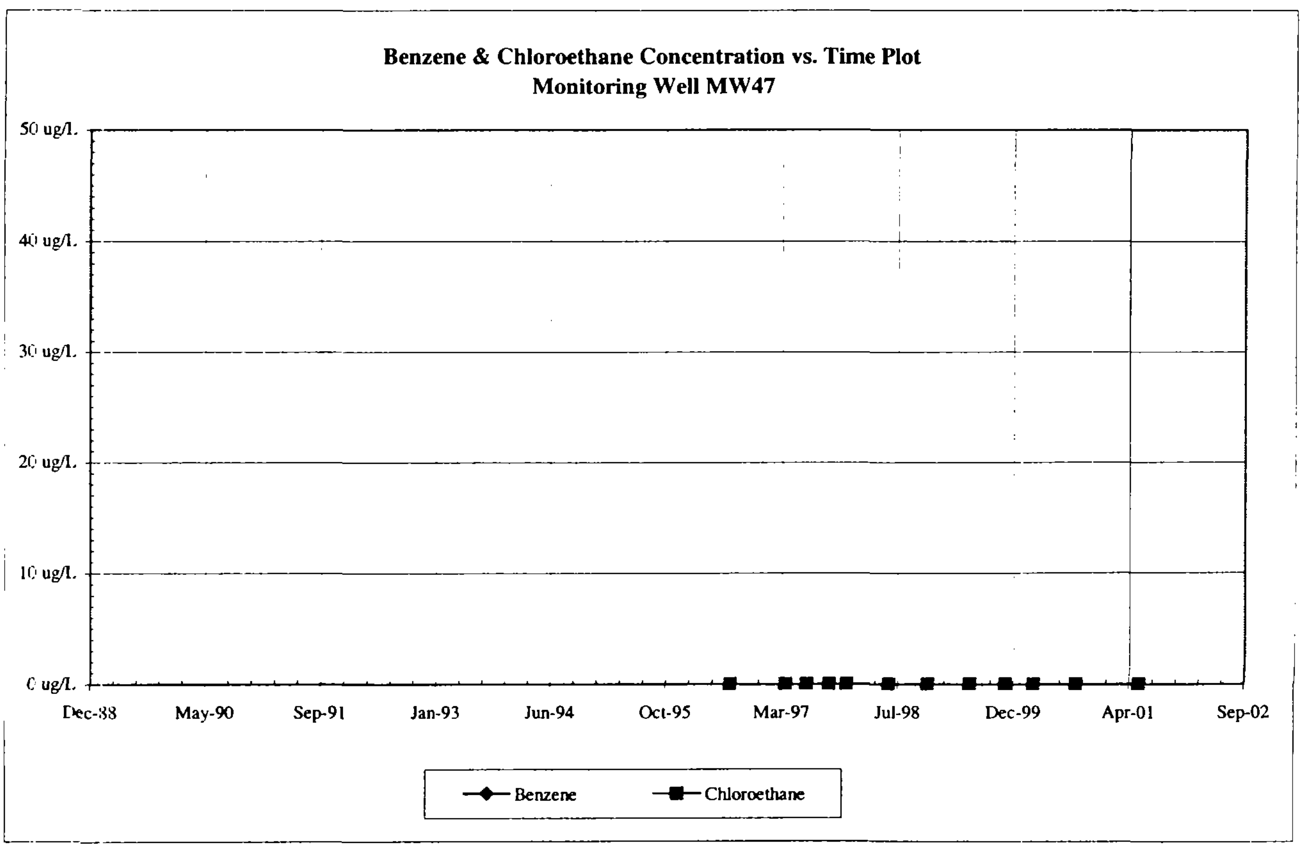
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well: MW47

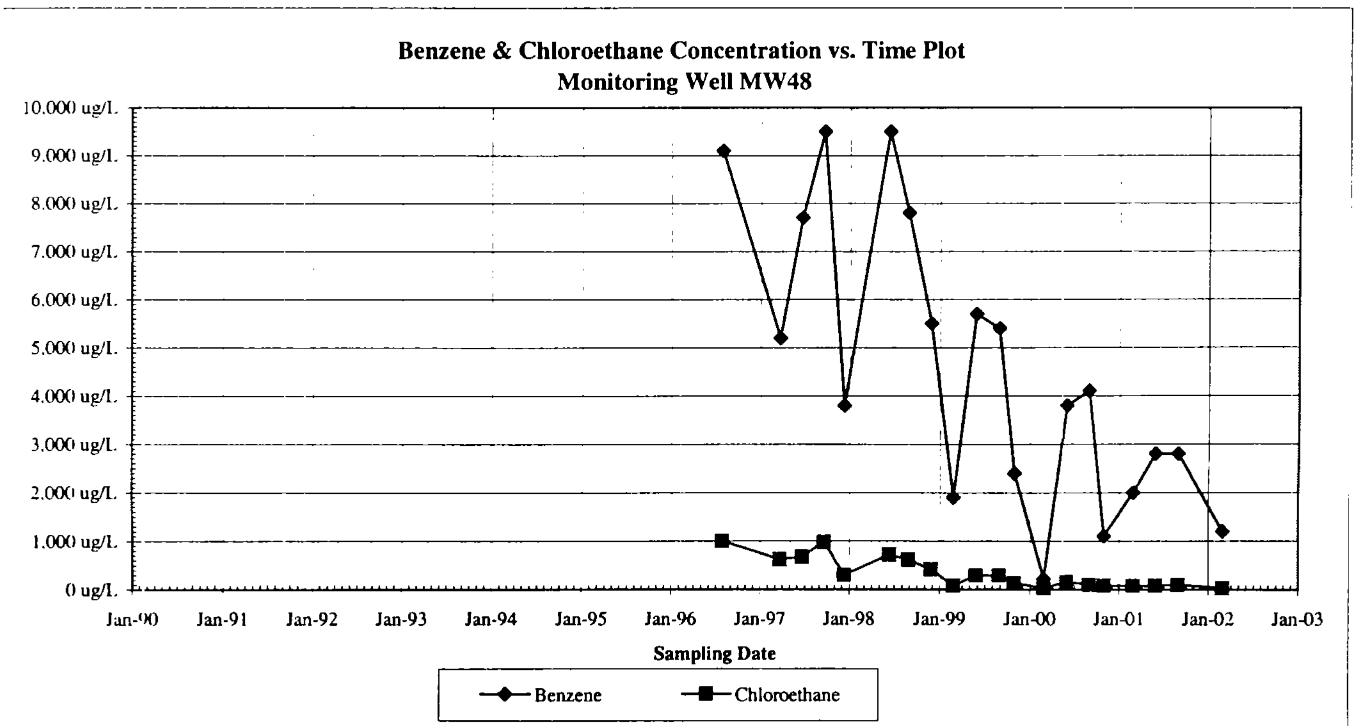
Date	Benzene	Chloroethane
BASELINE	10	10
August-89		
May-90		
December-94		
August-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
October-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL

BDL = Below the Detection Limit



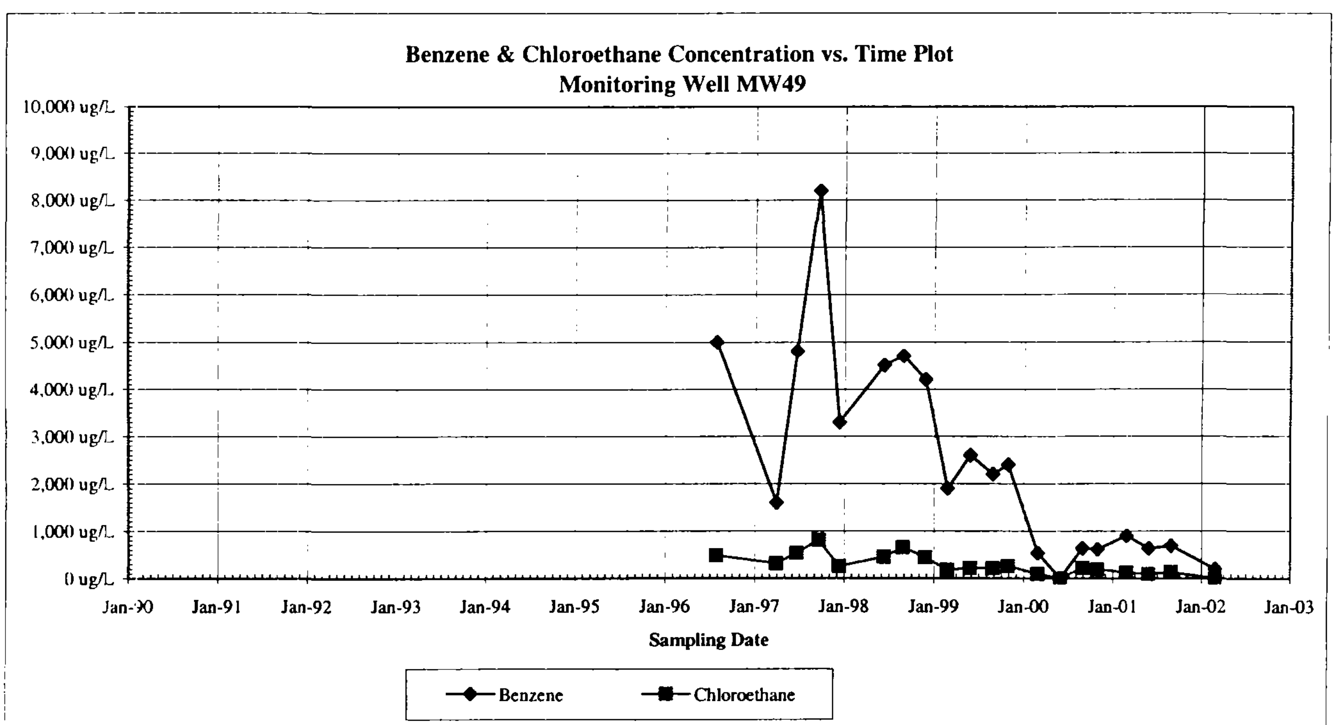
Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW48

Date	Benzene	Chloroethane
BASELINE	**9500**	**1000**
August-89		
May-90		
December-94		
August-96	9,100 ug/L	1,000 ug/L
March-97	5,200 ug/L	620 ug/L
June-97	7,700 ug/L	670 ug/L
September-97	9,500 ug/L	980 ug/L
December-97	3,800 ug/L	300 ug/L
June-98	9,500 ug/L	720 ug/L
September-98	7,800 ug/L	610 ug/L
December-98	5,500 ug/L	420 ug/L
March-99	1,900 ug/L	83 ug/L
June-99	5,700 ug/L	290 ug/L
September-99	5,400 ug/L	290 ug/L
November-99	2,400 ug/L	140 ug/L
March-00	220 ug/L	24 ug/L
June-00	3,800 ug/L	160 ug/L
September-00	4,100 ug/L	100 ug/L
November-00	1,100 ug/L	78 ug/L
March-01	2,000 ug/L	78 ug/L
June-01	2,800 ug/L	80 ug/L
September-01	2,800 ug/L	100 ug/L
March-02	1,200 ug/L	33 ug/L



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well MW49

Date	Benzene	Chloroethane
BASELINE	**6750**	**715**
August-89		
May-90		
December-94		
August-96	5,000 ug/L	480 ug/L
April-97	1,600 ug/L	310 ug/L
June-97	4,800 ug/L	540 ug/L
September-97	8,200 ug/L	810 ug/L
December-97	3,300 ug/L	250 ug/L
June-98	4,500 ug/L	450 ug/L
September-98	4,700 ug/L	650 ug/L
December-98	4,200 ug/L	440 ug/L
March-99	1,900 ug/L	180 ug/L
June-99	2,600 ug/L	220 ug/L
September-99	2,200 ug/L	210 ug/L
November-99	2,400 ug/L	260 ug/L
March-00	530 ug/L	91 ug/L
June-00	BDL	BDL
September-00	630 ug/L	220 ug/L
November-00	610 ug/L	190 ug/L
March-01	900 ug/L	120 ug/L
June-01	630 ug/L	91 ug/L
September-01	690 ug/L	130 ug/L
March-02	200 ug/L	BDL



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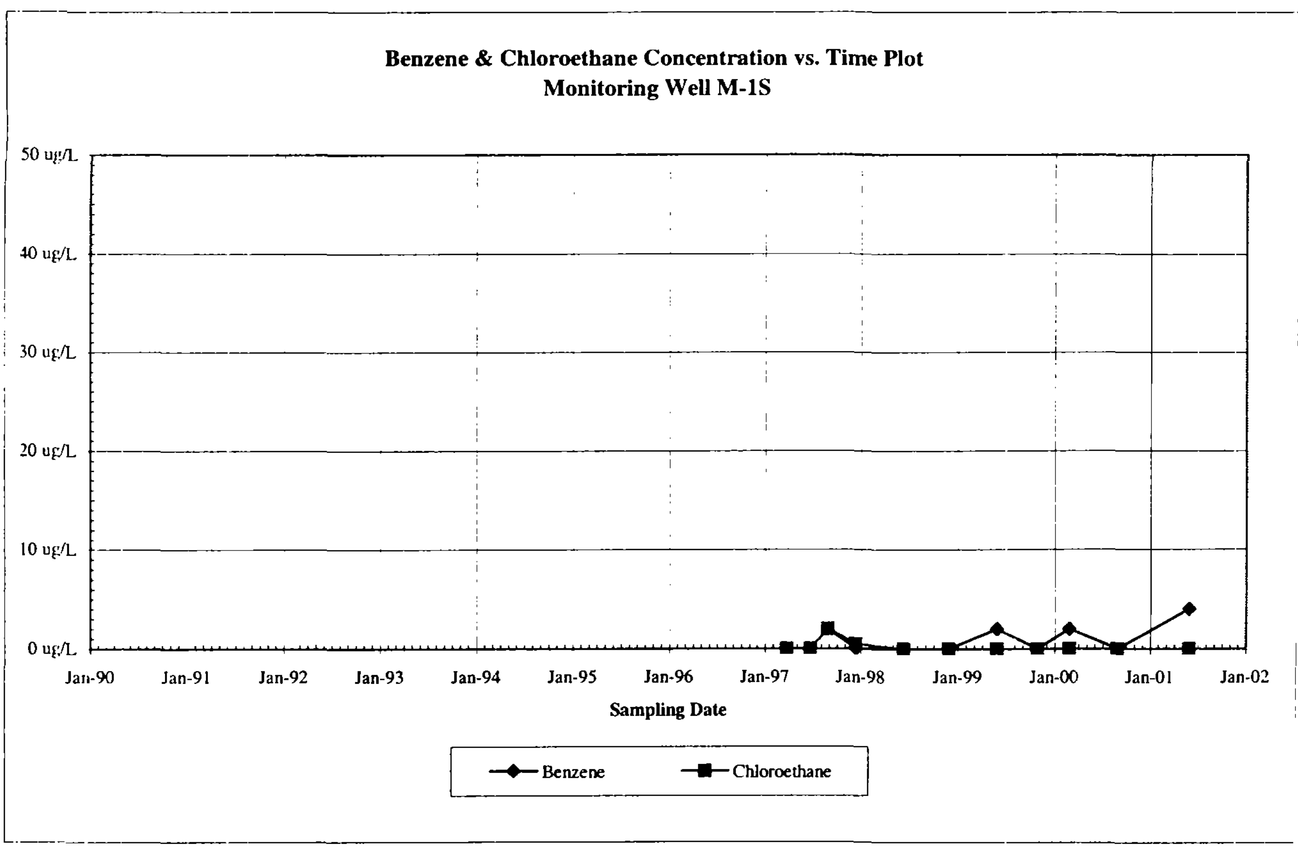
Concentration vs. Time Plot for
Upper Aquifer Monitoring Well: M-1S

Date	Benzene	Chloroethane
BASELINE	10	10
March-97	BDL	BDL
June-97	BDL	BDL
September-97	2 ug/L	2 ug/L
December-97	BDL	1 ug/L
June-98	BDL	BDL
December-98	BDL	BDL
June-99	2 ug/L	BDL
November-99	BDL	BDL
March-00	2 ug/L	BDL
September-00	BDL	BDL
June-01	4 ug/L	BDL

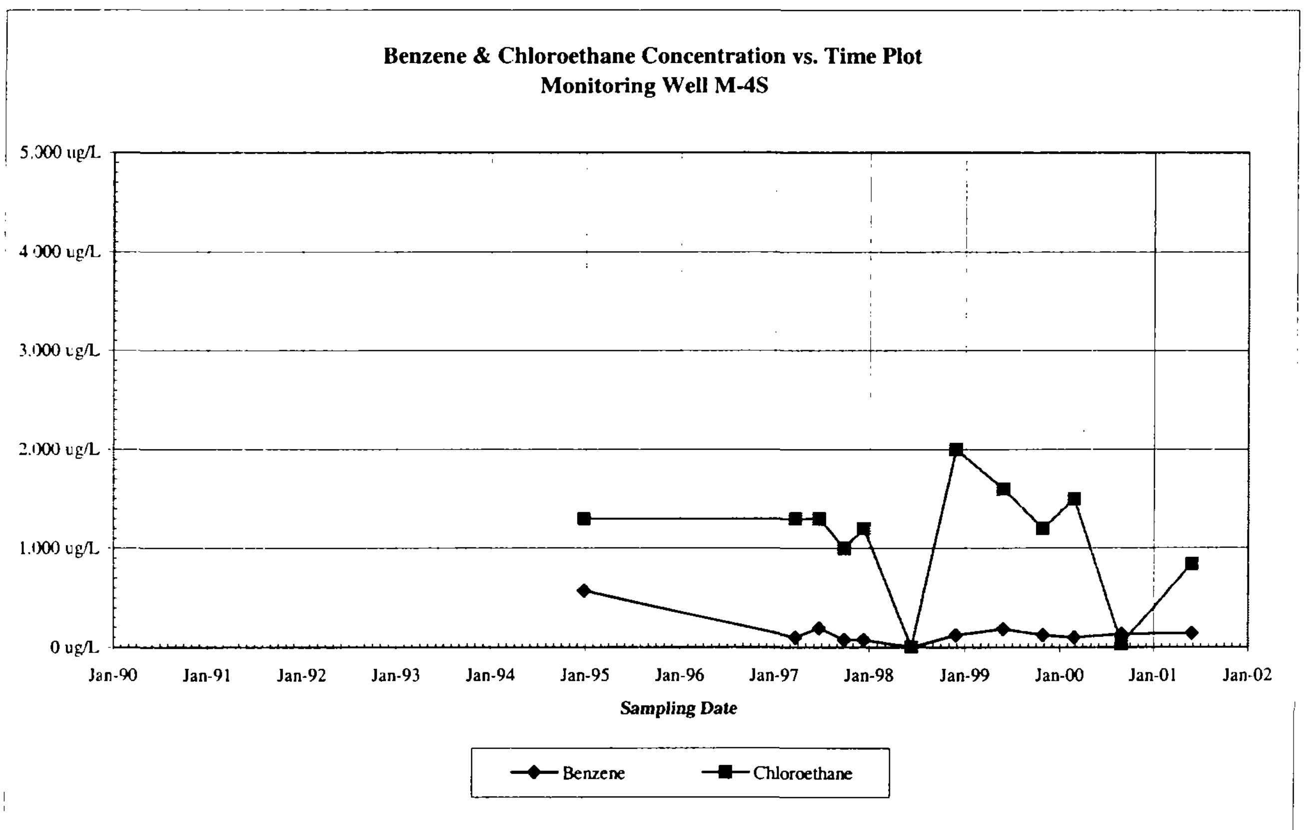
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Upper Aquifer Monitoring Well: M-4S

Date	Benzene	Chloroethane
BASELINE	**190**	**1300**
January-95	570 ug/L	1,300 ug/L
March-97	98 ug/L	1,300 ug/L
June-97	190 ug/L	1,300 ug/L
October-97	73 ug/L	1,000 ug/L
December-97	75 ug/L	1,200 ug/L
June-98	BDL	BDL
December-98	120 ug/L	2,000 ug/L
June-99	180 ug/L	1,600 ug/L
November-99	120 ug/L	1,200 ug/L
March-00	96 ug/L	1,500 ug/L
September-00	130 ug/L	37 ug/L
June-01	140 ug/L	840 ug/L

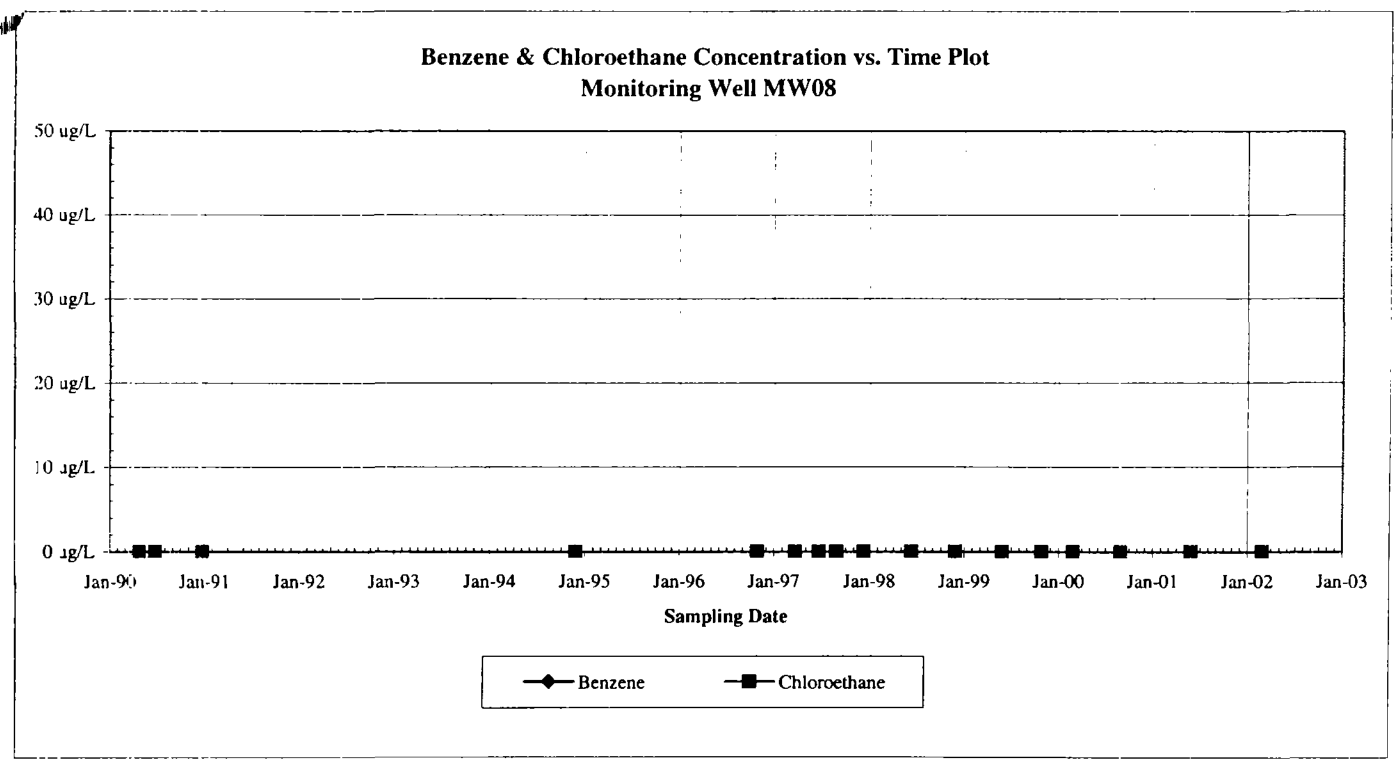
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW08

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
May-90	BDL	BDL
July-90	BDL	BDL
January-91	BDL	BDL
December-94	BDL	BDL
November-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

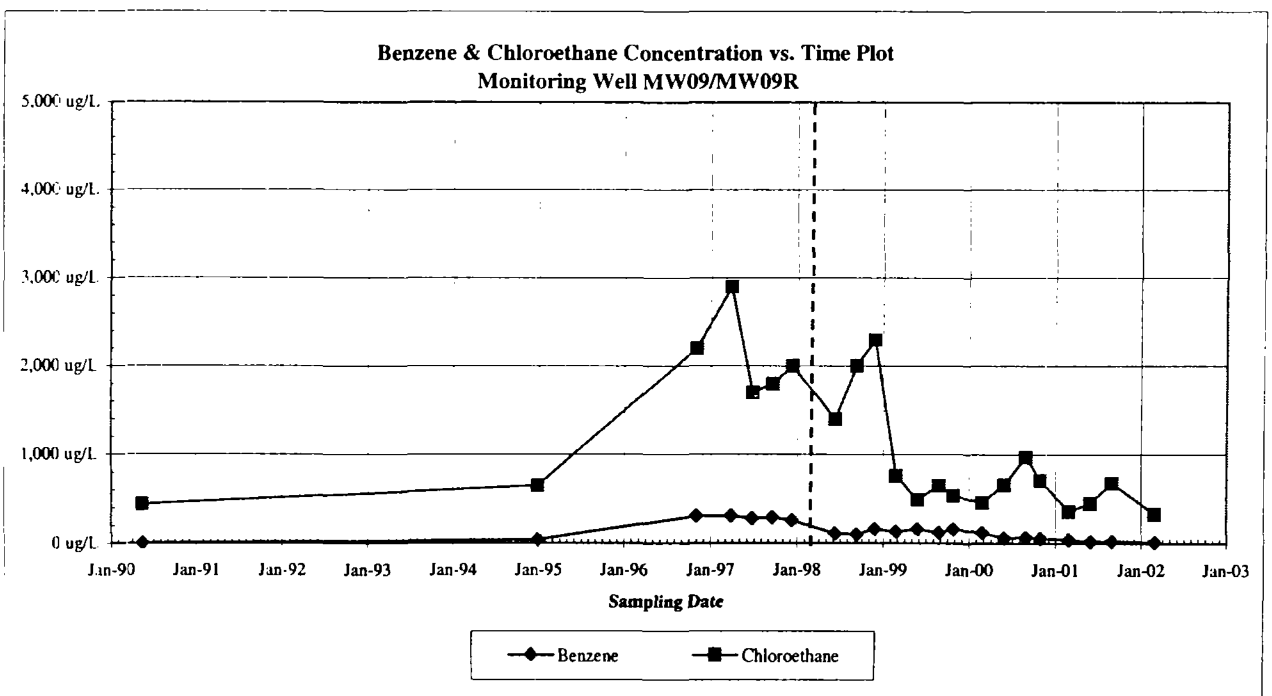
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW09/MW09R

Date	Benzene	Chloroethane	
BASELINE	**310**	**2900**	
August-89			
May-90	BDL	440 ug/L	
January-95	40 ug/L	650 ug/L	
November-96	310 ug/L	2,200 ug/L	
April-97	310 ug/L	2,900 ug/L	
June-97	280 ug/L	1,700 ug/L	
September-97	290 ug/L	1,800 ug/L	
December-97	260 ug/L	2,000 ug/L	MW09
June-98	110 ug/L	1,400 ug/L	MW09R
September-98	100 ug/L	2,000 ug/L	
December-98	160 ug/L	2,300 ug/L	
March-99	130 ug/L	760 ug/L	
June-99	160 ug/L	490 ug/L	
September-99	120 ug/L	650 ug/L	
November-99	160 ug/L	540 ug/L	
March-00	120 ug/L	460 ug/L	
June-00	60 ug/L	660 ug/L	
September-00	65 ug/L	970 ug/L	
November-00	55 ug/L	710 ug/L	
March-01	41 ug/L	360 ug/L	
June-01	19 ug/L	450 ug/L	
September-01	23 ug/L	680 ug/L	
March-02	11 ug/L	330 ug/L	

BDL = Below the Detection Limit

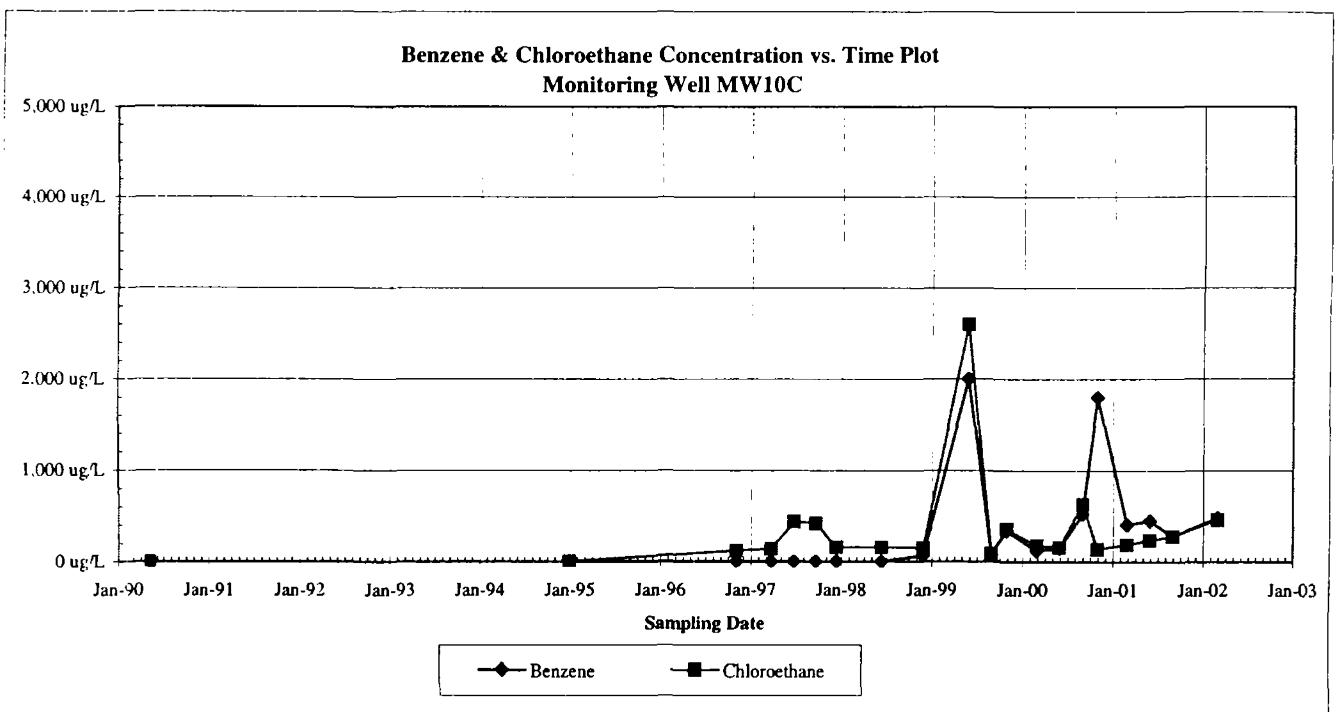


- - - - - - Line indicates change to replacement well

Concentration vs. Time Plot for Lower Aquifer Monitoring Well MW10C

Date	Benzene	Chloroethane
BASELINE	**150**	**420**
August-89		
May-90	BDL	BDL
January-95	BDL	BDL
November-96	BDL	120 ug/L
March-97	BDL	140 ug/L
June-97	BDL	440 ug/L
September-97	BDL	420 ug/L
December-97	BDL	160 ug/L
June-98	BDL	160 ug/L
December-98	66 ug/L	150 ug/L
June-99	2,000 ug/L	2,600 ug/L
September-99	83 ug/L	88 ug/L
November-99	340 ug/L	360 ug/L
March-00	120 ug/L	180 ug/L
June-00	150 ug/L	160 ug/L
September-00	520 ug/L	630 ug/L
November-00	1,800 ug/L	140 ug/L
March-01	410 ug/L	190 ug/L
June-01	450 ug/L	240 ug/L
September-01	280 ug/L	280 ug/L
March-02	480 ug/L	460 ug/L

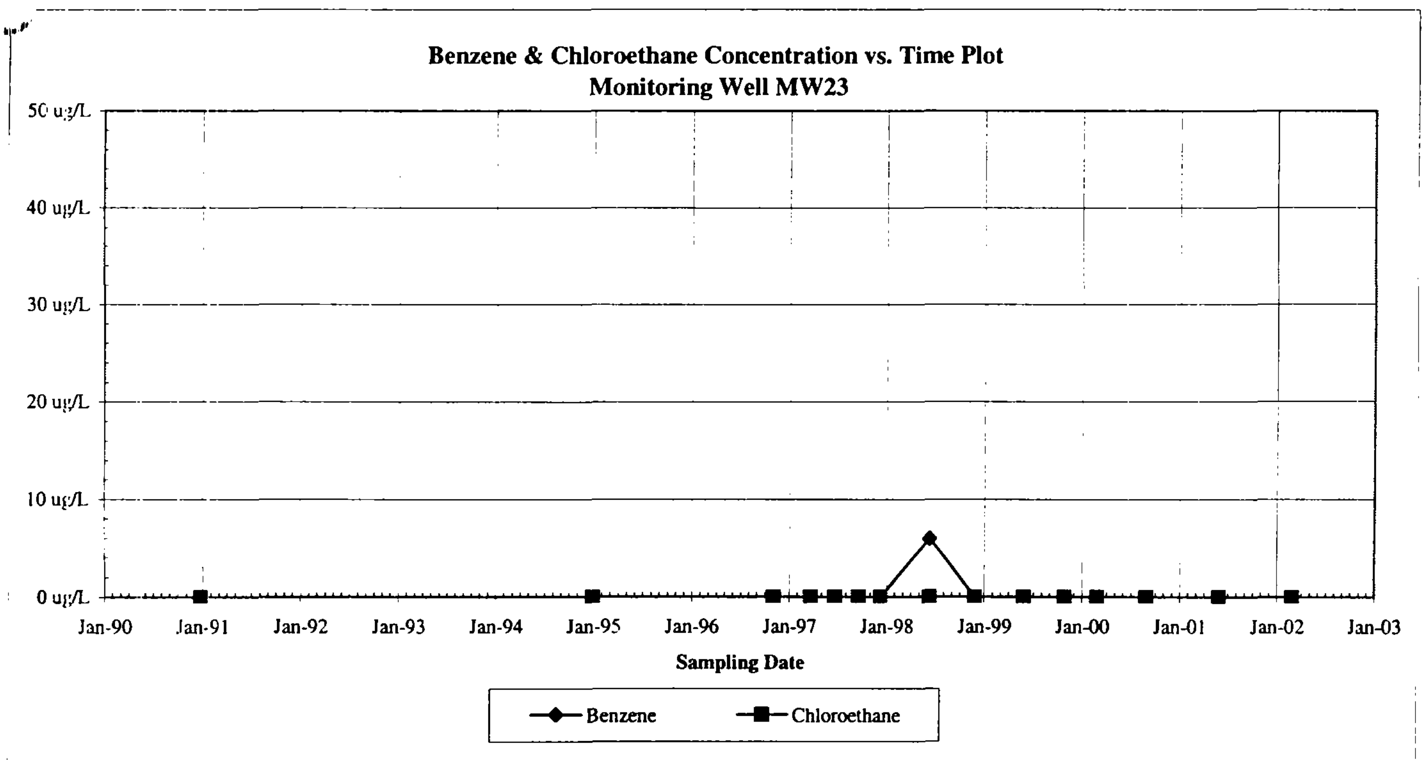
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW23

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
January-91	BDL	BDL
January-95	BDL	BDL
November-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	6 ug/L	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

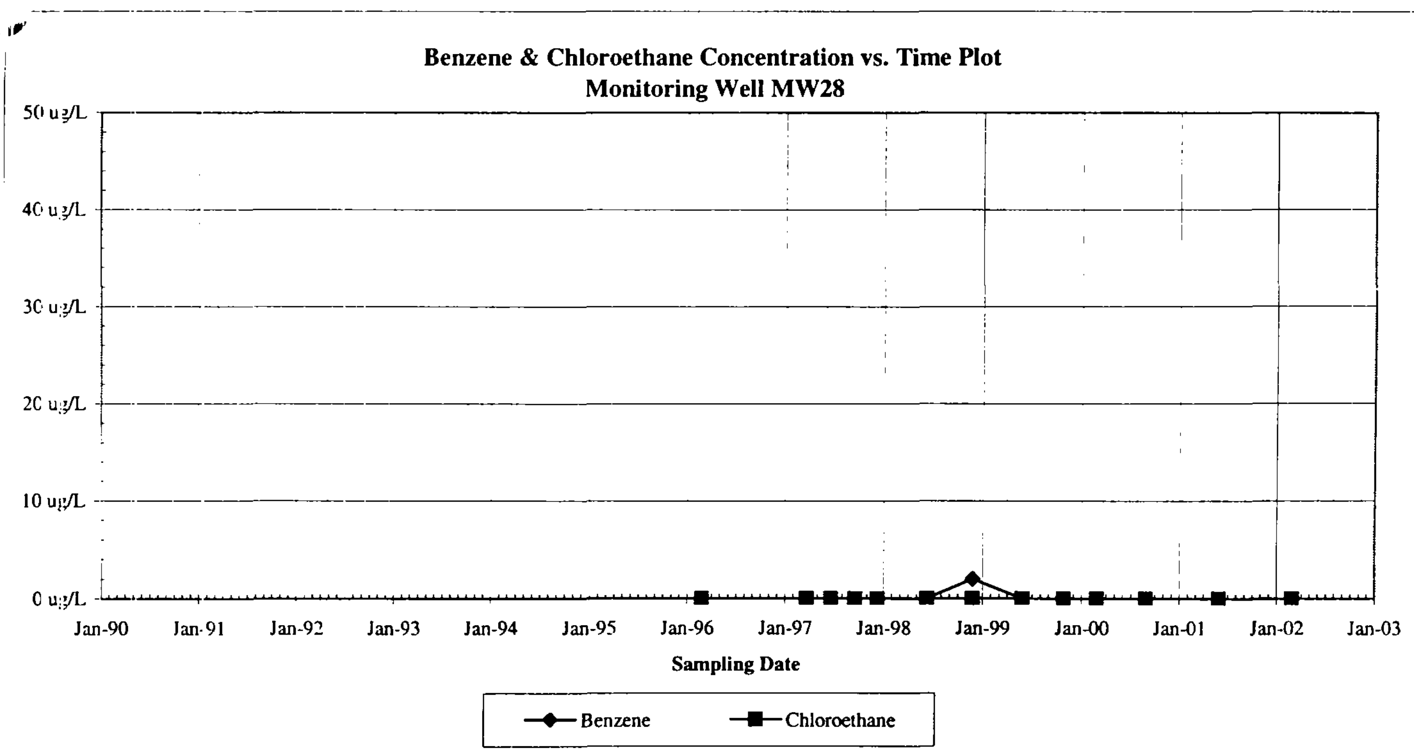
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW28

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
January-95		
March-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	2 ug/L	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

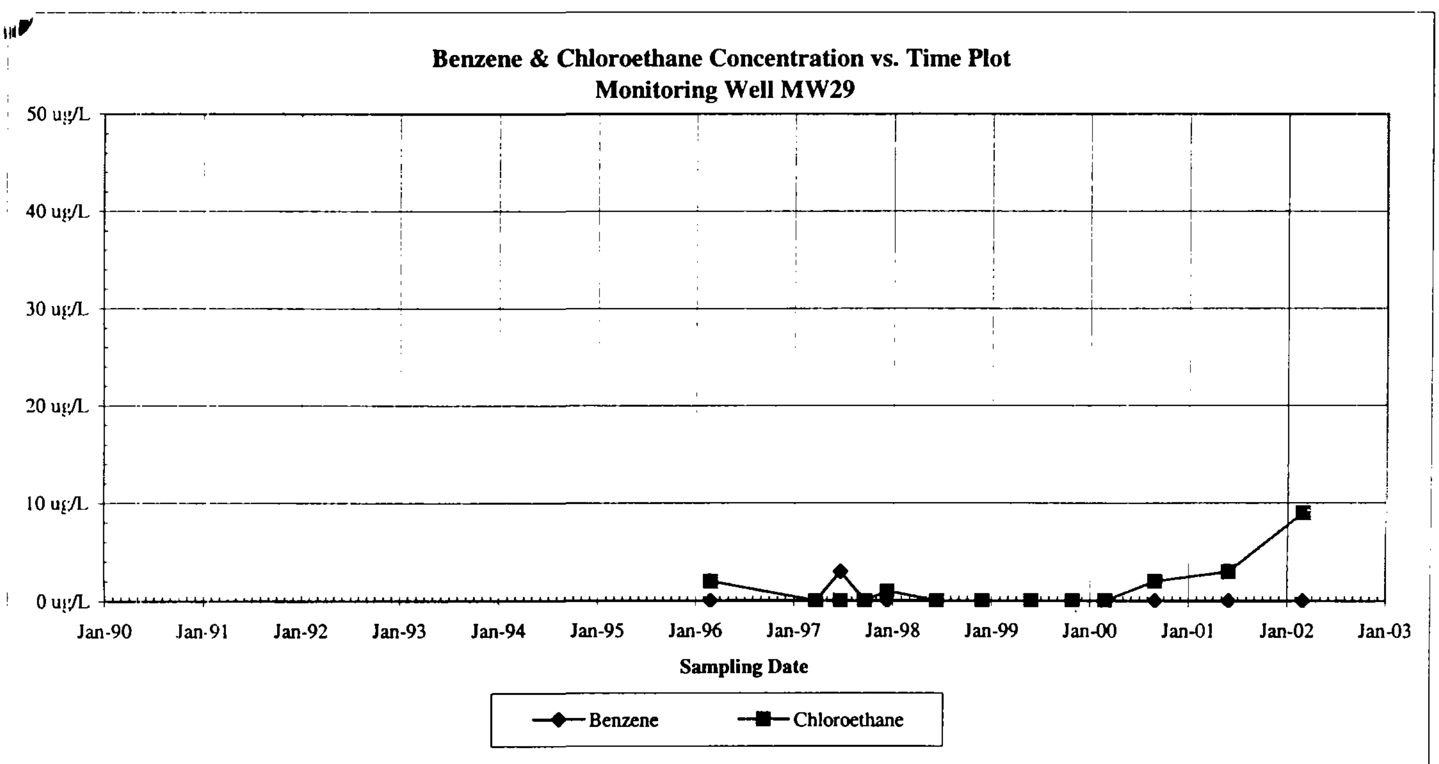
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW29

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
January-95		
March-96	BDL	2 ug/L
March-97	BDL	BDL
June-97	3 ug/L	BDL
September-97	BDL	BDL
December-97	BDL	1 ug/L
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	2 ug/L
June-01	BDL	3 ug/L
March-02	BDL	9 ug/L

BDL = Below the Detection Limit



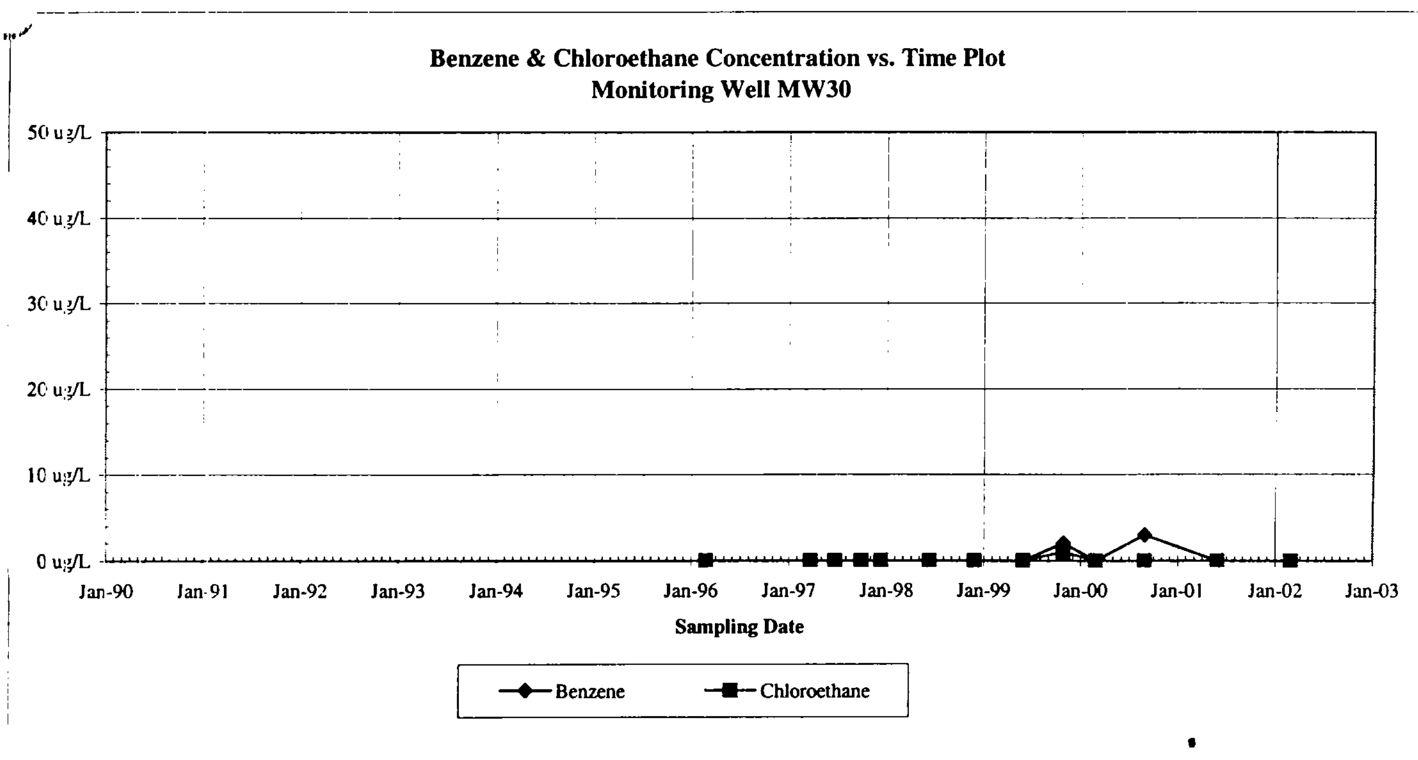
JMK/JMS/CAS
J 209\0603 ACS\Database\Timetrnd_GWMP_LA.xls[MW29]

9/4/2002

Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW30

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
January-95		
March-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
October-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	2 ug/L	1 ug/L
March-00	BDL	BDL
September-00	3 ug/L	BDL
June-01	BDL	BDL
March-02	BDL	BDL

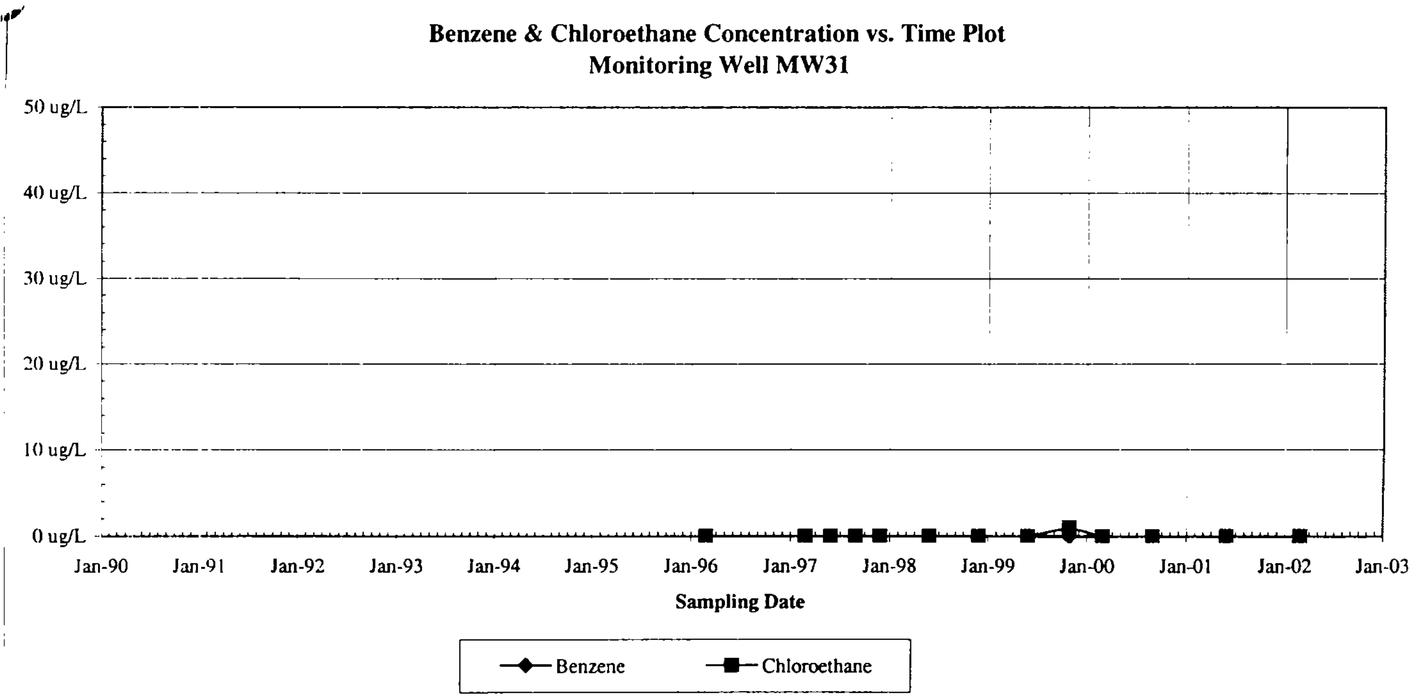
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW31

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
January-95		
March-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	1 ug/L
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

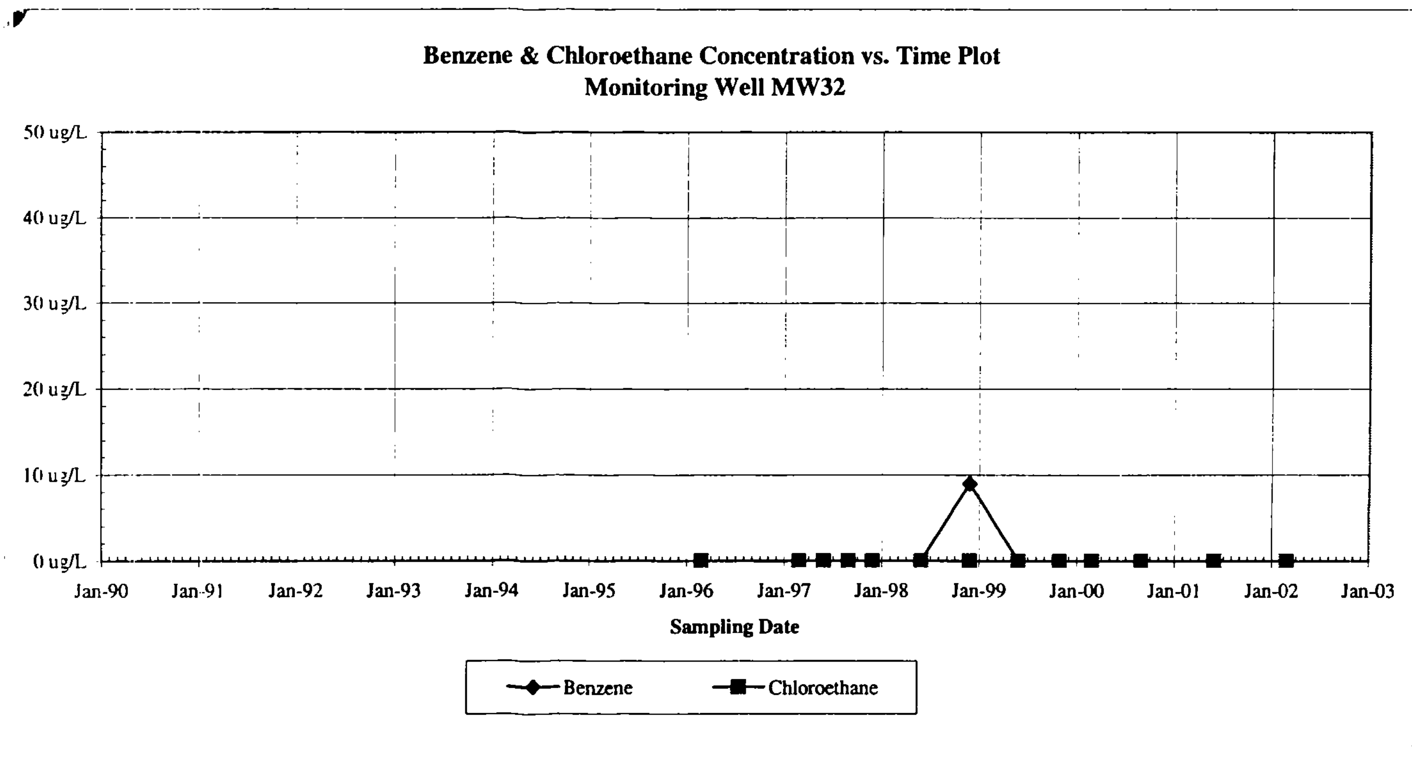
BDL = Below the Detection Limit



Concentration vs. Time Plot for Lower Aquifer Monitoring Well MW32

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
January-95		
March-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	9 ug/L	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

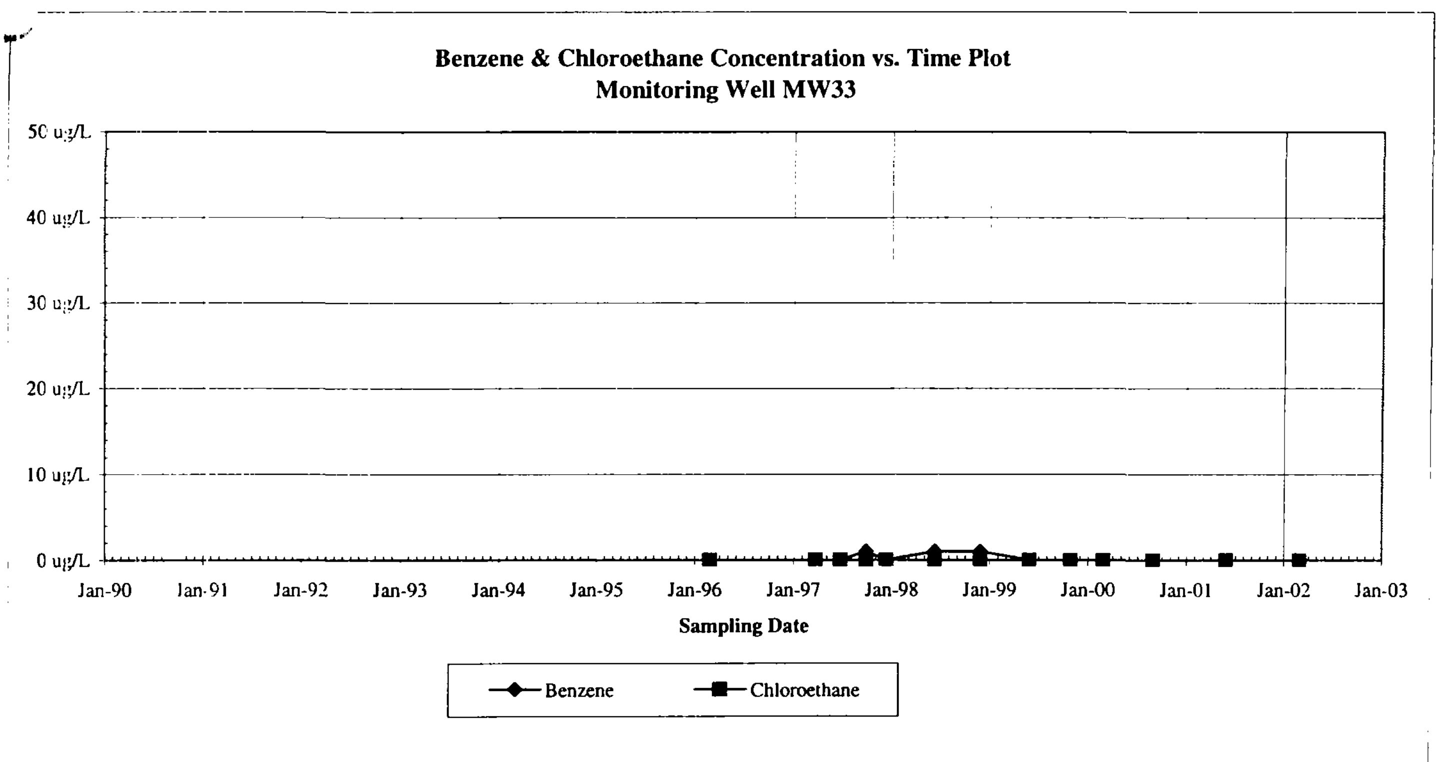
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW33

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
January-95		
March-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
October-97	1 ug/L	BDL
December-97	BDL	BDL
June-98	1 ug/L	BDL
December-98	1 ug/L	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

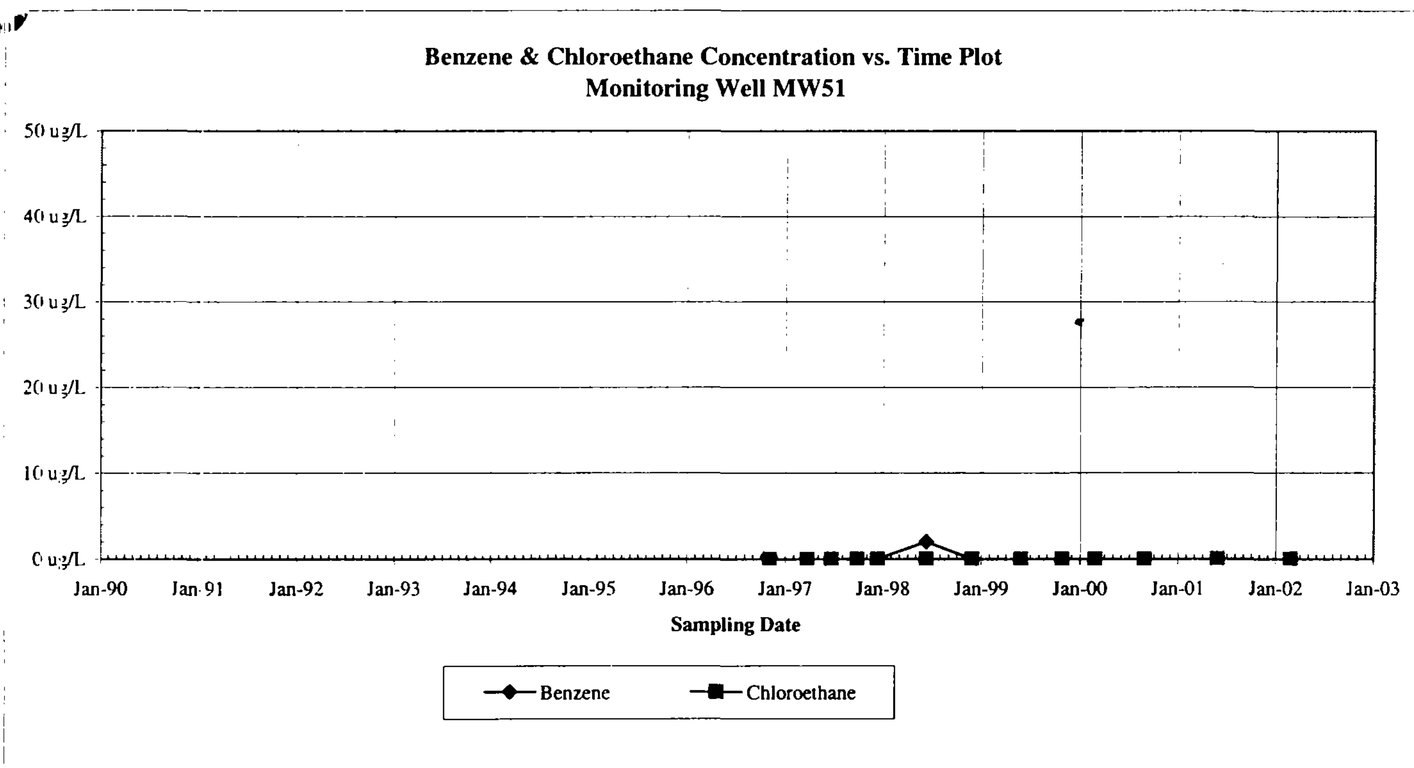
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW51

Date	Benzene	Chloroethane
BASELINE	**100**	**100**
August-89		
May-90		
January-95		
November-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
October-97	BDL	BDL
December-97	BDL	BDL
June-98	2 ug/L	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

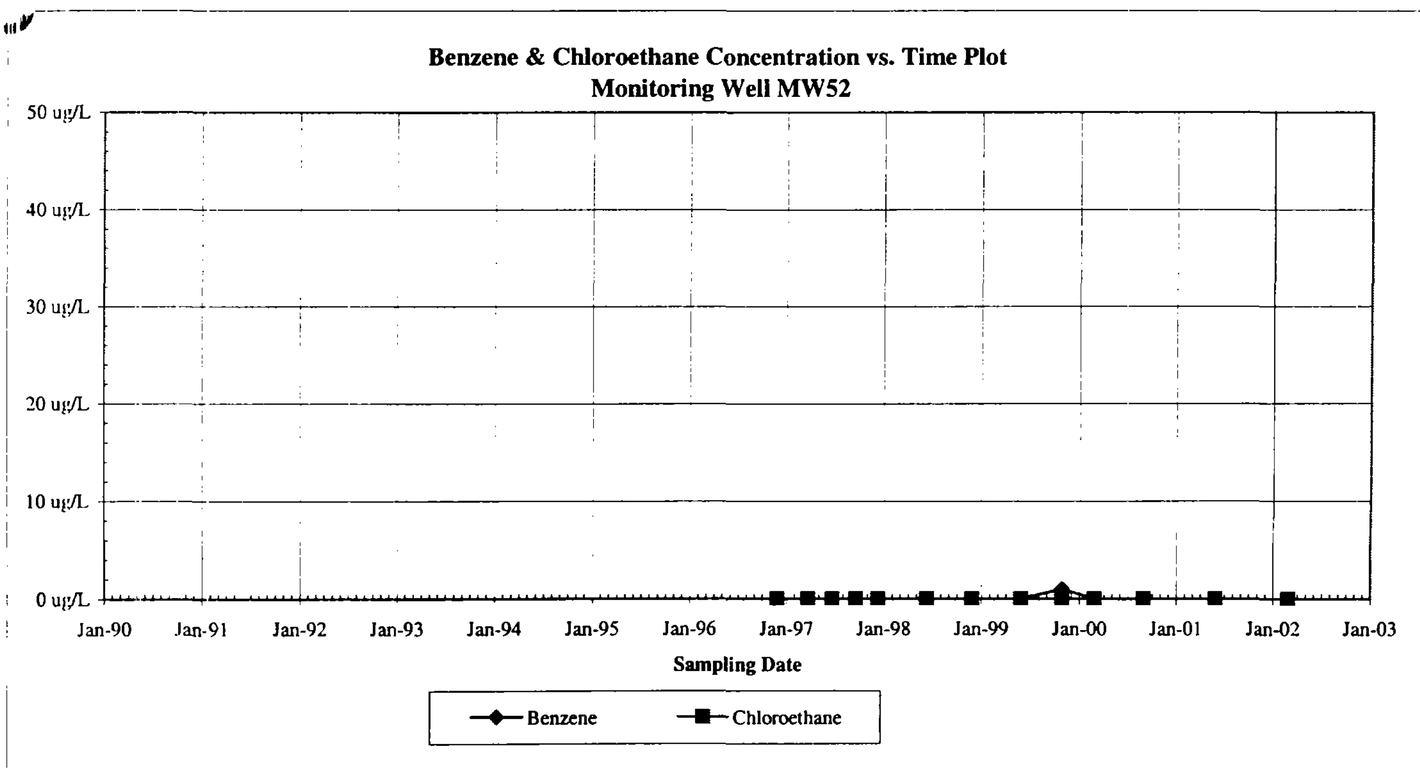
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW52

Date	Benzene	Chloroethane
BASELINE	**100**	**100**
August-89		
May-90		
January-95		
December-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	1 ug/L	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

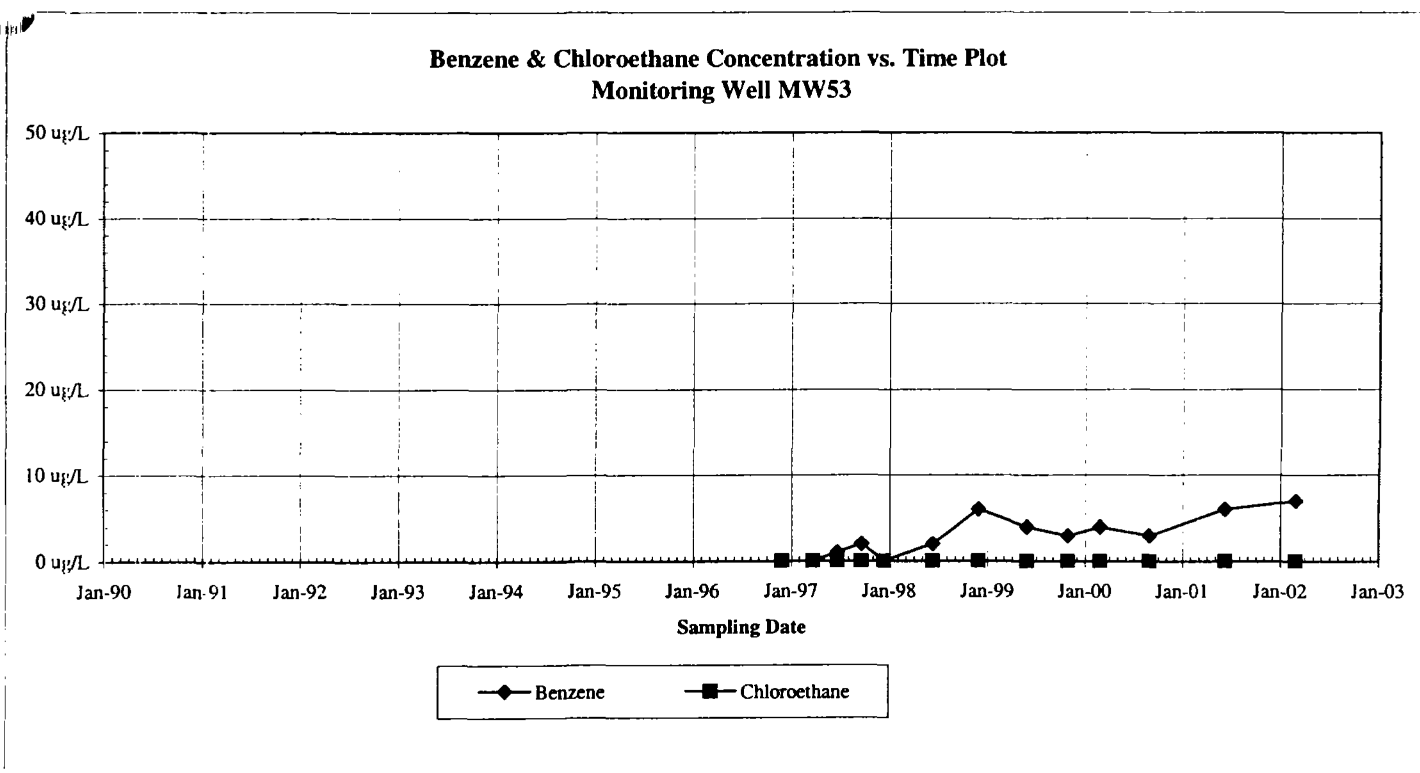
BDL = Below the Detection Limit



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW53

Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
January-95		
December-96	BDL	BDL
March-97	BDL	BDL
June-97	1 ug/L	BDL
September-97	2 ug/L	BDL
December-97	BDL	BDL
June-98	2 ug/L	BDL
December-98	6 ug/L	BDL
June-99	4 ug/L	BDL
November-99	3 ug/L	BDL
March-00	4 ug/L	BDL
September-00	3 ug/L	BDL
June-01	6 ug/L	BDL
March-02	7 ug/L	BDL

BDL = Below the Detection Limit

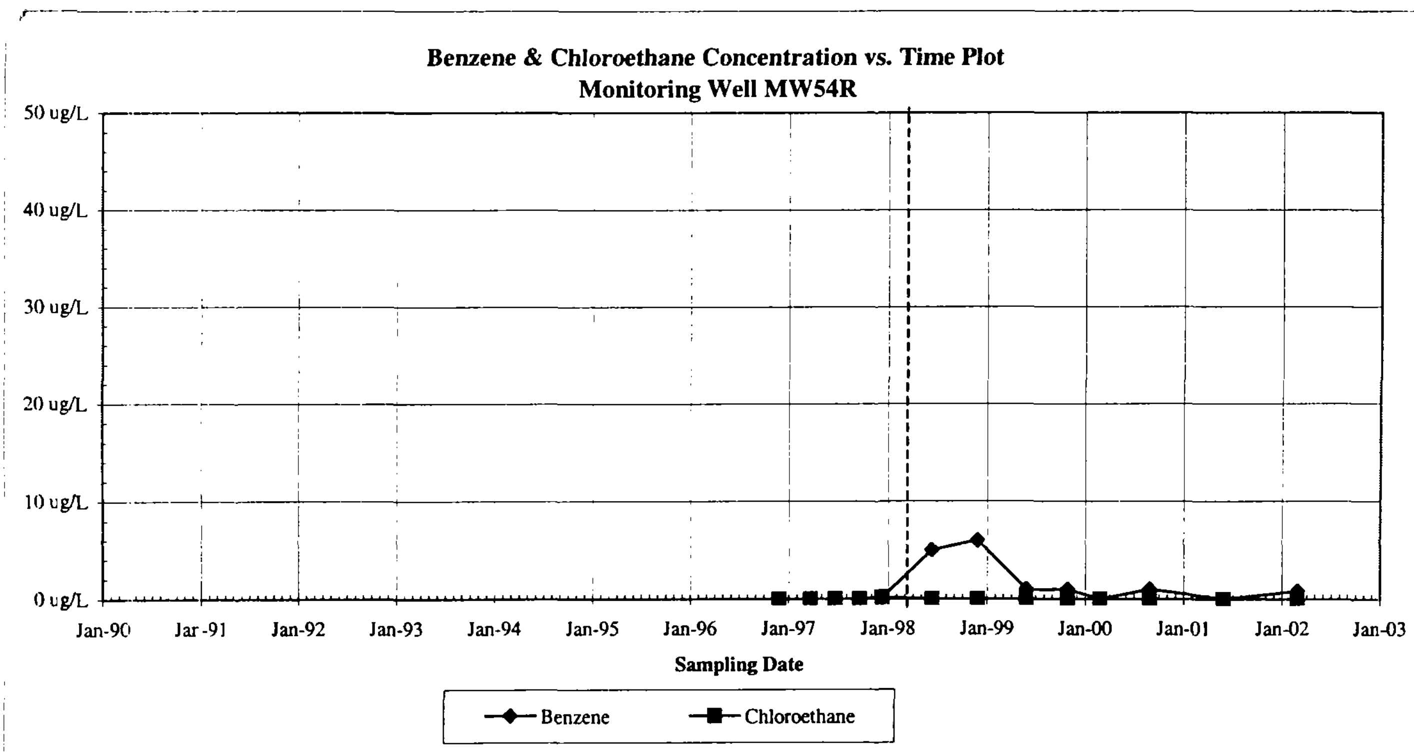


Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW54R

Date	Benzene	Chloroethane	
BASELINE	**10**	**10**	
August-89			
May-90			
January-95			
December-96	BDL	BDL	
March-97	BDL	BDL	
June-97	BDL	BDL	
September-97	BDL	BDL	
December-97	0.1 ug/L	0.2 ug/L	
June-98	5 ug/L	BDL	<- MW54R
December-98	6 ug/L	BDL	
June-99	1 ug/L	BDL	
November-99	1 ug/L	BDL	
March-00	BDL	BDL	
September-00	1 ug/L	BDL	
June-01	BDL	BDL	
March-02	1 ug/L	BDL	

BDL = Below the Detection Limit

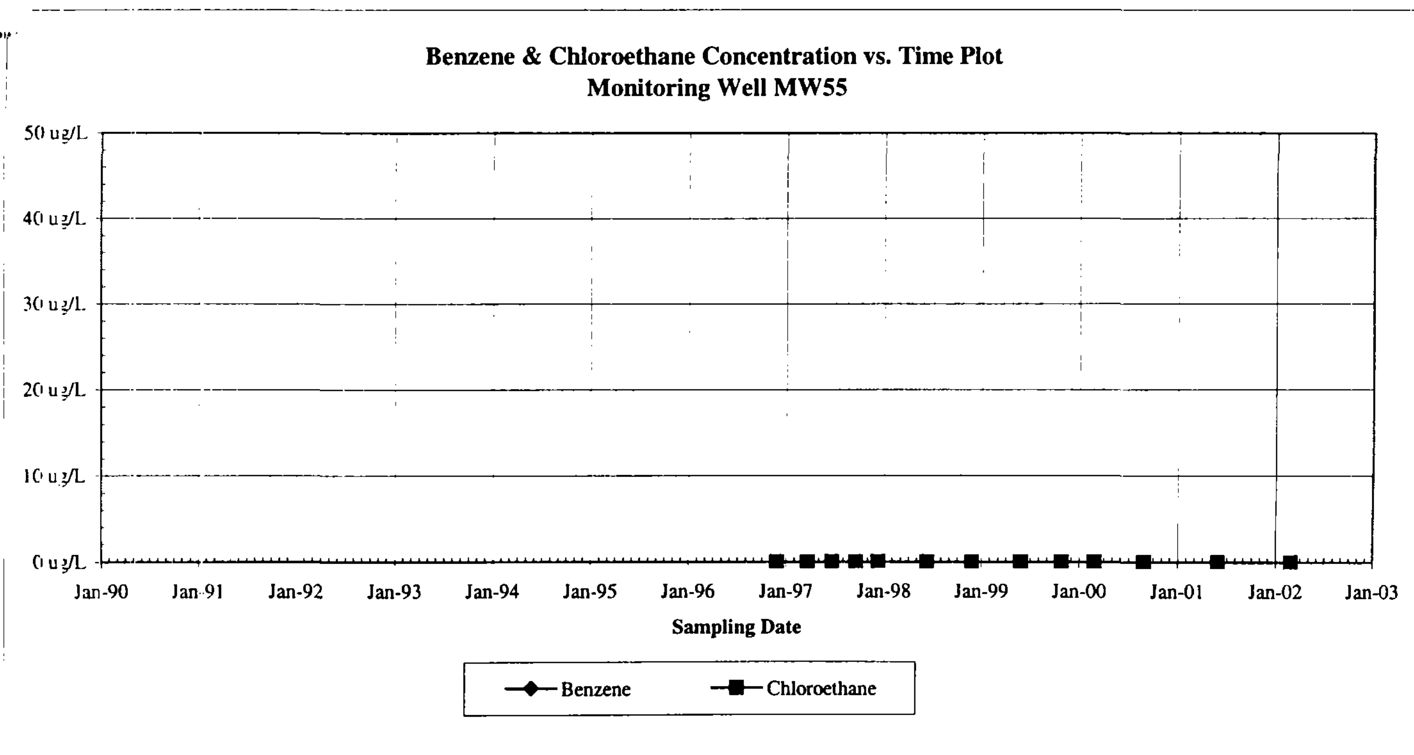
MW54 was damaged by a vehicle and was replaced with MW54R



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well MW55

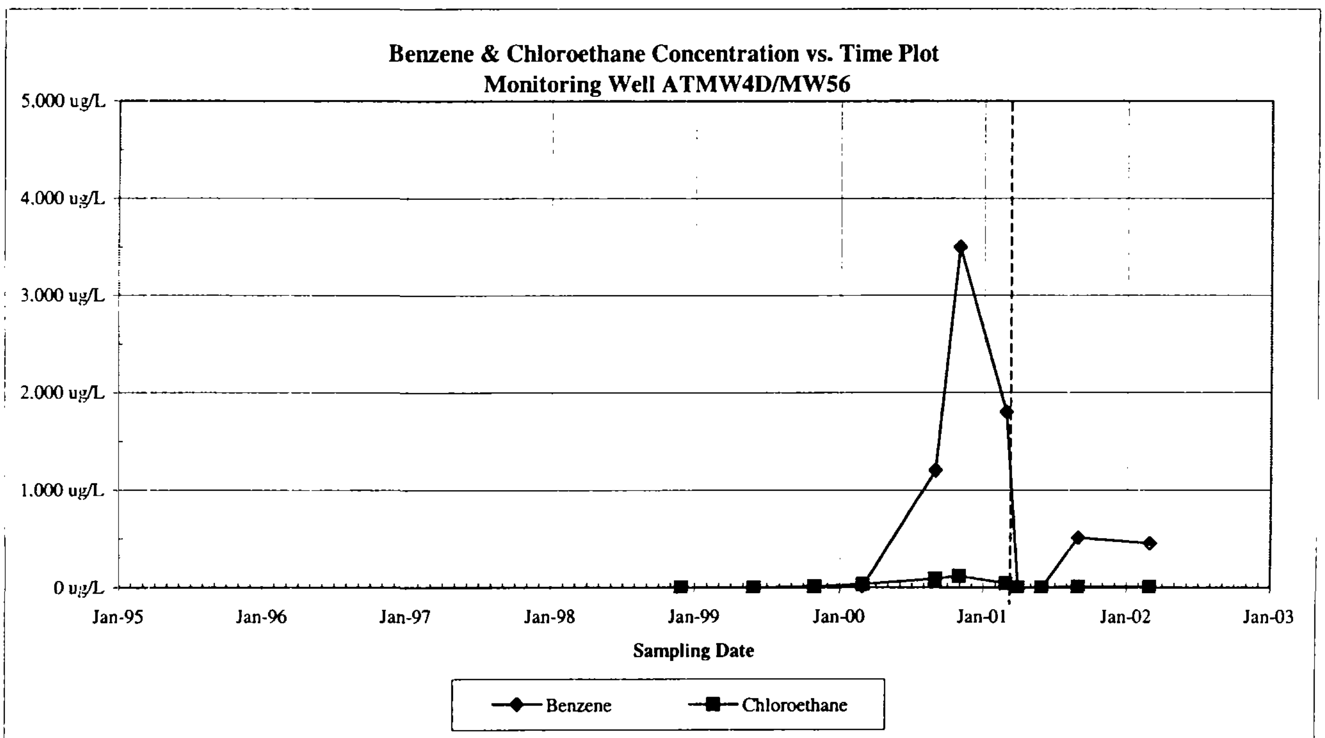
Date	Benzene	Chloroethane
BASELINE	**10**	**10**
August-89		
May-90		
January-95		
December-96	BDL	BDL
March-97	BDL	BDL
June-97	BDL	BDL
September-97	BDL	BDL
December-97	BDL	BDL
June-98	BDL	BDL
December-98	BDL	BDL
June-99	BDL	BDL
November-99	BDL	BDL
March-00	BDL	BDL
September-00	BDL	BDL
June-01	BDL	BDL
March-02	BDL	BDL

BDL = Below the Detection Limit



Concentration vs. Time Plot for
Lower Aquifer Monitoring Well ATMW4D-MW56

Date	Benzene	Chloroethane	
BASELINE	-	-	
December-98	BDL	BDL	
June-99	BDL	BDL	
November-99	3 ug/L	9 ug/L	
March-00	12 ug/L	34 ug/L	
September-00	1,200 ug/L	88 ug/L	
November-00	3,500 ug/L	120 ug/L	
March-01	1,800 ug/L	42 ug/L	ATMW4D
April-01	BDL	BDL	MW56
June-01	BDL	BDL	
September-01	510 ug/L	10 ug/L	
March-02	450 ug/L	8 ug/L	



APPENDIX B

FIELD SAMPLING PLAN

FIELD SAMPLING PLAN
LONG-TERM GROUNDWATER MONITORING PLAN

AMERICAN CHEMICAL SERVICE, INC.
NPL SITE
GRIFFITH, INDIANA

MWH File No.: 2090603

Prepared For:

ACS RD/RA Executive Committee

Prepared By:
MWH, Inc.
27755 Diehl Road, Suite 300
Warrenville, Illinois 60555

September 2002

FIELD SAMPLING PLAN
LONG-TERM GROUNDWATER MONITORING PLAN

AMERICAN CHEMICAL SERVICE, INC.
NPL SITE
GRIFFITH, INDIANA

MWH File No.: 2090603

Prepared For:

ACS RD/RA Executive Committee

Prepared by: Chad A. Smith, P.G. — September 20, 2002 (Date)
Professional Hydrogeologist

Approved by: Peter J. Vagt, Ph.D., CPG — September 20, 2002 (Date)
Vice President

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APPENDICES

ACRONYMS AND ABBREVIATIONS

ACS	American Chemical Services, Inc.
FSP	Field Sampling Plan
IAC	Indiana Administrative Code
IDW	Investigation-Derived Waste
IUPPS	Indiana Underground Plant Protection Service, Inc.
MWH	Montgomery Watson Harza
NPL	National Priority List
PCB	poly-chlorinated biphenyls
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
QC	Quality Control
RD/RA	Remedial Design/Remedial Action
SOP	Specific Operating Procedures
U.S. EPA	United States Environmental Protection Agency

1.0 INTRODUCTION

This Field Sampling Plan (FSP) presents, in specific terms, the requirements and procedures for conducting specific Remedial Design/Remedial Action (RD/RA) site activities at the American Chemical Service, Inc. (ACS) National Priority List (NPL) Site located in Griffith, Indiana. This FSP will ensure that the field sampling protocols are documented and reviewed in a consistent manner and the data collected are scientifically valid and defensible.

This FSP defines the specific sampling methods for the groundwater monitoring activities, as outlined in the revised Long-Term Groundwater Monitoring Plan (the Plan). The groundwater monitoring activities include collecting water level measurements and groundwater samples from site monitoring wells, collecting samples from residential wells, and all associated quality assurance and quality control sampling. There is also the potential for abandonment and replacement of piezometers and monitoring wells.

This FSP is to be used in conjunction with the approved November 2001 Quality Assurance Project Plan (QAPP), prepared by MWH, Inc. (formerly Montgomery Watson). The QAPP covers all sampling and analytical work for groundwater monitoring activities, groundwater treatment plant effluent and off-gas compliance sampling, and confirmation sampling for excavation of poly-chlorinated biphenyl (PCB) impacted soils. The treatment plant effluent and off-gas sampling and the PCB-impacted soil confirmation sampling each have their own corresponding FSP or related Work Plan, as mentioned in Section 5.1 of the QAPP.

This FSP is required reading for all participating MWH field personnel. All personnel involved with these field activities will be required to comply with the procedures documented in this FSP to maintain comparability and representativeness of the collected and generated data.

This FSP is presented in the following sections:

- Section 2.0 presents the project background and current site conditions;
- Section 3.0 presents the project organization and key personnel;
- Section 4.0 presents the field operations and specific procedures to be followed during field work operations;
- Section 5.0 presents the procedures to be followed during sample collection;
- Section 6.0 presents the procedures to be followed during field data collection; and
- Section 7.0 presents the procedures for proper record keeping.

2.0 PROJECT BACKGROUND

The project background and current site conditions are described in Section 2.0 of the QAPP, and a more detailed description of the revised monitoring plan is provided in Section 3.0 of the Plan. Tables 8, 10, and 11 of the Plan outline the specific locations to be monitored and the frequency of sampling events. Figures 1 and 2 of the Plan show the water level monitoring network, and Figures 3 and 4 of the Plan show the sample well network in the upper and lower aquifers, respectively.

3.0 PROJECT ORGANIZATION

At the direction of the ACS RD/RA Executive Committee and the approval of the U.S. EPA, MWH has overall responsibility for the implementation and analysis of the RD/RA sampling at ACS. The various management and project organization responsibilities for these Site activities are described in Section 3.0 of the QAPP.

4.0 FIELD OPERATION PROCEDURES

The field procedures associated with the Plan are described below. A copy of the relevant specific operating procedures (SOPs) are provided in Appendix A. A copy of the field data collection forms which will be utilized as necessary during fieldwork activities are provided in Appendix B.

4.1 UTILITY CLEARANCE

If drilling or other subsurface operations are conducted that require utility clearance, then the following general utility clearance procedures for drilling operations will be conducted at a minimum:

- Contact the Indiana Underground Plant Protection Service, Inc. (IUPPS) at least 2 days prior to planned activities at 1-800-382-5544 or www.iupps.org.

- If working on private land, contact the landowner to verify the locations of their underground utilities, since IUPPS will not go on private land without the landowner present.

- If the utility markings at a specific drilling location are unclear or it is not certain that the location is clear of utilities, a hand auger or tile probe will be driven to at least 4 feet below ground surface to verify that no utilities are present.

4.2 MONITORING WELL INSTALLATION

All monitoring wells will be installed in accordance with the procedures described in the Monitoring Well Installation SOP provided in Appendix A. These procedures are in accordance with 312 Indiana Administrative Code (IAC) 13-8-3.

4.3 MONITORING WELL DEVELOPMENT

All monitoring wells will be developed in accordance with the procedures described in the Monitoring Well Development SOP provided in Appendix A.

4.4 MONITORING WELL ABANDONMENT

Any monitoring wells requiring abandonment will be abandoned in accordance with the procedures described in the Monitoring Well Abandonment SOP provided in Appendix A. These procedures are in accordance with 312 IAC 13-10-2.

4.5 EQUIPMENT DECONTAMINATION

Any equipment used for groundwater sampling or monitoring well installation, development, or abandonment, will be decontaminated prior to and between uses. Decontamination will consist of varying combinations of high-pressure hot water rinse, Liquinox® or Alconox® wash, potable water rinse, and distilled water rinse. In general, all groundwater sampling equipment that is not dedicated to a well will be decontaminated between sampling locations using a Liquinox® or Alconox® wash followed by a distilled water rinse. Augers, drilling rods, and other drilling equipment will be decontaminated with a high-pressure hot water rinse (steam cleaner). If a hot water pressure rinse is needed, then a method of containing and disposal of the decontamination water will be utilized (i.e., a temporary decontamination pad).

4.6 INVESTIGATION-DERIVED WASTE

Investigation-Derived Waste (IDW) resulting from the activities described in this FSP includes liquid, solid, or general refuse. Liquid IDW includes groundwater collected during purging or developing during groundwater sampling, and decontamination wash and rinse water. All liquid IDW will be disposed at the MWH treatment plant, where it will be treated and discharged to the wetlands. Prior to the completion of the cap, solid IDW, such as soil cuttings generated during drilling activities, will be disposed within future ISVE areas. After the final cap is complete, MWH will arrange for proper off-site disposal of any solid IDW. General refuse IDW includes disposable sampling equipment and PPE, such as disposable nitrile gloves. This material will be placed in trash bags and disposed of as solid waste at a local landfill, as long as it is not grossly contaminated. Grossly contaminated refuse will be disposed of in the same manner as solid IDW.

5.0 SAMPLE COLLECTION AND HANDLING PROCEDURES

This section describes the field sampling methods for groundwater sampling, sample handling, and quality control. The associated SOPs are provided in Appendix A. The relevant forms are provided in Appendix B.

5.1 SAMPLING PROCEDURES

5.1.1 Groundwater Sampling

All groundwater sampling will be conducted in accordance with the groundwater sampling SOP in Appendix A. This SOP is based on the U.S. EPA *Low-Flow Groundwater Sampling Procedures* (EPA/540/S-95/504). All groundwater sampling will be completed using low-flow sampling methods. While purging, field measurements for pH, conductivity, temperature, dissolved oxygen, oxidation-reduction potential, and turbidity will be recorded using an in-line flow-through cell. When these readings have stabilized for three consecutive readings the samples will be collected. Refer to the groundwater sampling SOP for stabilization requirements.

Trip blanks, equipment blanks, duplicates, and matrix spike samples will be collected and analyzed to assess the quality of the data resulting from the field sampling and analytical programs. The Field Crew will also ensure that the appropriate number of temperature blanks, which are supplied by the laboratory, are included in the sample shipment. For further discussion of these quality control samples, please refer to Section 4.3 of the QAPP. The general level of the quality control (QC) effort will be one field duplicate and one field blank for every 10 or fewer investigative samples. One matrix spike and one matrix spike duplicate sample will be collected for every 20 or fewer investigative samples.

5.2 SAMPLE MANAGEMENT

Sample management and chain-of-custody procedures are provided in Section 6.1 and 6.2 of the QAPP.

6.0 FIELD MEASUREMENTS

6.1 STATIC WATER LEVEL AND TOTAL DEPTH MEASUREMENTS

Groundwater elevation measurements will be collected quarterly from site wells in the monitoring network as defined in the Plan. Groundwater elevation measurements will be collected from both the upper and lower aquifers. When determining the elevation of the water table across the Site, water level measurements will be collected in at the appropriate locations within a 24-hour period. When detected, the presence of floating hydrocarbon will be confirmed by measurement with an electronic interface probe.

Depth to groundwater will be measured using an electric water level indicator. The groundwater elevation measurements will be made from a surveyed reference location permanently marked at the top of the well casing. If no marking is present, then the measurement will be made from the north side of the top of casing. The probe tip will be lowered into the well slowly until the indicator beeps, indicating that water has been contacted. The indicator tape will then be held so that the probe tip hangs as straight as possible, and then raised and lowered until the probe is at the surface of the water. The depth to groundwater will then be measured off of the tape to the nearest 0.01 foot. The measurement will be repeated after approximately 30 seconds to assure that water levels have equilibrated and that the first measurement was accurate. If water levels differ by more than 0.01 feet, then successive water level readings will be measured until water levels are consistent over a 30-second period. Measurements will be recorded on the field form (Appendix B), and transferred to the master list at the treatment plant. After each measurement, the probe will be decontaminated with an Alconox® wash.

If necessary, total depth measurements will be collected using an electric water level indicator. Total depth measurements will not be collected immediately prior to groundwater sampling, as this will disturb any silt that has accumulated in the well bottom. If total depth measurements are needed during a groundwater sampling event, they will be collected at the completion of the sampling at the particular location. Total depth measurements will be measured by lowering the probe tip slowly until it hits the bottom of the well. The indicator tape will then be held so that the probe tip hangs as straight as possible, and then the tape will be raised and lowered until the probe tip is as the bottom of the well. The total depth will then be measured off of the tape to the nearest 0.01 foot and recorded in the field book or appropriate form. After each measurement, the probe and all tape that came in contact with the groundwater will be decontaminated using an Alconox® wash.

6.2 WATER QUALITY PARAMETER MEASUREMENT

Water quality parameters, such as temperature, pH, conductivity, turbidity, and dissolved oxygen, will be measured using a Horiba U-22-2 water quality meter or equivalent. The specific requirements for water quality parameter measurements are discussed in the groundwater sampling SOP provided in Appendix A. Unless circumstances prevent it, a flow-through cell will be used to collect parameter measurements. The Horiba or equivalent meter will be calibrated in accordance with manufacturer's recommendations at the start of each work day, after any extended break, and if any suspect readings occur.

7.0 RECORD KEEPING

MWH will maintain field records sufficient to recreate field activities conducted. These records include both written observations or notes in the field log books as well as photographic documentation.

7.1 FIELD LOG BOOKS

All groundwater sampling activities will be recorded in a hard-cover, bound, waterproof field log book. There will be a field log book for each personnel or sampling team working at the Site. At the beginning of each day, the date, start time, weather, names of all sampling team members present, purpose of site visit, and level of personal protection being used will be entered. The names of visitors to the site and the purpose of their visit will also be recorded in the field logbook. Each page will have a page number and date at the top of the page, and the person making the entry will initial the bottom of each page, and will sign the last page. Any lines or areas left intentionally blank will have a single line drawn through the area to signify that no entries were made in that space.

The field log book will contain a detailed account of all activities at the site for each day. All problems, such as equipment or weather delays, will be noted in the field book. All details pertaining to the groundwater sampling activities will be entered into the field book. This includes, but is not limited to, water level measurements, groundwater quality parameter measurements, sample times and analyses for each location, and any quality control samples collected.

7.2 PHOTOGRAPHIC DOCUMENTATION

In the case that photographic documentation of groundwater sampling activities are needed or requested, all photographic information taken at the site by the sampling team will be entered into the field book. This information shall include the date, time, location, number and direction of photograph, and if necessary, a sketch of the area photographed.

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APPENDIX A

SPECIFIC OPERATING PROCEDURES

Groundwater Sampling
Monitoring Well Installation
Monitoring Well Development
Monitoring Well Abandonment

SPECIFIC OPERATING PROCEDURE

AMERICAN CHEMICAL SERVICE NPL SITE
GRIFFITH, INDIANA

GROUNDWATER SAMPLING

Developed: April 18, 2001 Approved: June 26, 2002

Scope: This procedure is applicable for groundwater sample collection from monitoring wells (upper and lower aquifer) and residential wells at the ACS NPL Site. All sampling procedures will follow U.S. EPA *Low-Flow Groundwater Sampling Procedures* (EPA/540/S-95/504). The residential wells will be sampled using a slightly modified approach, but samples will be collected under low-flow conditions.

Method: Low Flow Sampling

I. FIELD CHECKLIST

A. Paperwork to take to the site

1. Completed monitoring well construction summary for the wells to be sampled
2. Field Notebook
3. Health and Safety Plan
4. Chain of custody forms

B. Equipment to take to the site

1. Watch, or timing device
2. Electronic water level indicator
3. 5-gallon buckets
4. Plan for disposal of water
5. Decon solutions and buckets
6. Flow Cell
7. Pump and association equipment
8. Hand tools (socket set, hammer)
9. Sample bottles
10. Sample labels and tags
11. Well access (key)
12. Cooler(s) with ice
13. Packing Material (vermiculite, tape)

II. LOW FLOW SAMPLING AT MONITORING WELLS

A. Measure and record depth to water from top of the well casing with electronic water level indicator. Examine the water level indicator for evidence of sheen, oily surface or other immiscible fluids and record this information in the field log book. Do not measure the total depth, as this will disturb any sediment that may have accumulated in the bottom of the well. If needed, the total depth measurement can be collected after the completion of sampling.

B. Refer to monitoring well construction summary for depth to top of the well screen. Set the intake point of the pump or tubing at the center or slightly above the center of the screen, preferably without letting the pump hit the bottom of the well.

C. While attaching the pump to the tubing, inspect the tubing for signs of deterioration, such as cracks, kinks, and holes. If sever kinks and holes exist, replace the tubing. New tubing will always be used to replace the old tubing (as opposed to previously used tubing that has been decontaminated). Prior to use, new tubing will be decontaminated (inside and out) using an Alconox solution and de-ionized water rinse.

D. Begin purging the well at a rate between 0.1 and 0.5 liters per minute (L/min). Confirm the purge rate by measuring the amount of water purged in one minute with a graduated measuring device, such as a 40 ml VOA sample container ***(If a 40-ml vial is used, assure that this vial will not be used for sampling by throwing the cap away and clearly labeling the vial "NOT FOR SAMPLING").*** Record this information in the field log book. Observe the purge water for evidence of a sheen, oily surface, or other immiscible fluids and record this information in the field log book. The pumping rates and respective duration to fill a 40-ml vial are as follows:

- 0.1 L/min = 24 seconds
- 0.2 L/min = 12 seconds
- 0.3 L/min = 8 seconds
- 0.4 L/min = 6 seconds
- 0.5 L/min = 5 seconds

E. While purging, field parameter measurements for pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature, and turbidity will be collected in line using the flow cell. Record these measurements in the field book at an interval between 3 and 5 minutes. At slower purging rates (0.1 L/min, longer intervals (5 min) between readings should be used.

F. Measure and record the depth to water from the top of casing periodically to determine if drawdown is occurring during purging. Drawdown of less than 1 foot in upper aquifer wells, and 2 feet in lower aquifer wells, is desirable. If drawdown is greater than these amounts, lower pump rates until the water level stabilizes, and record in field book.

G. If the water column in a well is less than three feet, then the well will be labeled "dry" and will not be sampled. A water column of at least three feet is required to collect a representative and accurate groundwater sample. The intake of the Grundfos sampling pump is at the top of the pump. During operation, the Grundfos pump cools itself by contact with the surrounding water. Without the cooling effect of the water, the pump will overheat and fail to operate properly, and also cause the groundwater temperature to increase, which may alter the sample composition by driving off VOCs. Because drawdown of up to one foot is expected during sampling, at least two feet of water is required above the intake of the pump. Since the pump length is about 1 foot, the pump intake will be located at least one foot above the bottom of the well. These requirements are the basis for minimum three feet of water in a well.

If the water level does not stabilize during purging, and the well is pumped dry, then the purging activities will cease at this well. The well will then be immediately sampled once the water level has returned to its original level, or within 24 hours, whichever is sooner.

H. When the parameter readings have stabilized, sample bottles can then be filled. Stabilization is defined as three consecutive readings within:

± 10% for temperature
± 0.1 for pH
± 3% for conductivity
± 10% for DO
± 10% or <10 NTU for turbidity
± 10 mV for ORP

I. Disconnect the flow-through cell and collect the sample(s) from the tubing ***prior*** to the flow-through cell. See Section V of this SOP for sample collection order. Samples shall be placed in a cooler and iced immediately after collection.

J. Purge water will be contained in 5-gallon buckets with lids, so that the amount of water purged during sampling can be recorded in the field log book and safely transported. All purge water will be transported to the MWH treatment building, where it will be treated and discharged to the wetlands.

K. Upon completion of sampling, promptly remove the sampling pump from the well. Decontaminate the pump by inserting the pump into a container prepared with a potable water and Alconox solution, followed by a distilled water rinse. Water generated during decontamination will also be collected and transported to the

MWH treatment building. Fresh decontamination and rinse water will be prepared every day.

III. LOW FLOW SAMPLING AT RESIDENTIAL WELLS

A. Collection of groundwater samples from residential wells involves attaching a hose to an outside spigot and running the water through the flow cell at low-flow rates. No pumps are involved.

B. Begin purging the well at a rate between 0.1 and 0.5 L/min, if possible. Confirm the purge rate by measuring the amount of water purged in one minute with a graduated measuring device, such as a 40 ml VOA sample container ***(If a 40-ml vial is used, assure that this vial will not be used for sampling by throwing the cap away and clearly labeling the vial "Not for sampling").*** Record this information in the field log book. The pumping rates and respective duration to fill a 40-ml vial are as follows:

- 0.1 L/min = 24 seconds
- 0.2 L/min = 12 seconds
- 0.3 L/min = 8 seconds
- 0.4 L/min = 6 seconds
- 0.5 L/min = 5 seconds

C. While purging, field parameter measurements for pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature, and turbidity will be collected in line using the flow cell. Record these measurements in the field book at an interval between 3 and 5 minutes. At slower purging rates (0.1 L/min, longer intervals (5 min) between readings should be used.

D. When the parameter readings have stabilized, sample bottles can then be filled. Stabilization is defined as three consecutive readings within:

± 10% for temperature
± 0.1 for pH
± 3% for conductivity
± 10% for DO
± 10% or <10 NTU for turbidity
± 10 mV for ORP

E. Disconnect the flow-through cell and collect the sample(s) from the tubing ***prior*** to the flow-through cell. See Section V of this SOP for sample collection order. Samples shall be placed in a cooler and iced immediately after collection.

F. Purge water will be contained in 5-gallon buckets so that the total volume of purge water can be recorded. Purge water from residential wells may be spilled onto the ground in an inconspicuous manner and away from the residence.

G. If the residential well sampling event coincides with the monitoring well sampling, the residential wells will be sampled prior to the monitoring wells to prevent cross-contamination of the samples.

IV. SAMPLE LABELING AND TAGGING

A. Sample labels and tags are used in conjunction with chain-of-custody documents to ensure sample identification, preservation, and custody requirements are maintained. Each label and tag will be labeled with a sample identifier code as defined below.

A three letter designation will be used for identifying the sampling site. The project identifier will be "ACS", to signify the American Chemical Service, Inc. NPL site.

Each groundwater sample will be identified by a two letter code, "GW" to identify the sample as a groundwater sample from a monitoring well or residential well.

The sample type code will be followed by a 2-5 digit alpha-numeric code to indicate sample location. This code will correspond to the monitoring well number (i.e., MW34) or residential well (i.e., PW-D).

The final two digits will signify the sampling round number.

For example, a groundwater sample collected from monitoring well MW-35 during round 12 will have the following sample label: ACS-GW-MW35-12.

B. U.S. EPA Sample Tags are used to identify all samples collected under the U.S. EPA Contract Laboratory Program (CLP). Tags are affixed to each to the bottles using a loop around the neck of the bottle. The information on the sample tag is filled in completely, with the sample identifier code described above.

V. SAMPLE COLLECTION AND PREPARATION

A. All sample containers received from the laboratory will meet the specifications and protocols of U.S. EPA guidance document EPA540/R-93/051/12-92. All containers will have the appropriate preservatives already added to the containers.

B Volatile Organic Compounds

1. Remove the plastic cap and Teflon® coated septum. If vial and/or cap appear to be defective, discard and use a new vial.

2. Carefully fill the vial with water at continuous low flow conditions until a meniscus (mound of water) forms on the top. Make sure that the preservative is not washed out of the vial during filling. A recommended method is to fill the vial to just below the surface. Then fill the cap and use it to form the meniscus, thus preventing any accidental washing out of the preservative.

3. Carefully replace the cap on the meniscus. This will force a small amount of water off the top. Check the vial for bubbles by inverting vial and gently tapping the side of the vial. Bubbles will rise to the top, if present. If bubbles are present, top off with a few drops of sample and replace the cap again. If bubbles persist for three attempts, discard vial and try again. Place samples into cooler with ice upon sample completion.

C. Inorganics. Complete metals sampling following collection of VOC sample while continuing to purge the well at low-flow rates. Fill required containers to the shoulder. Place sample cooler into cooler with ice.

D. Semi-volatiles and PCBs. For sampling of semi-volatile organic compounds and PCBs, the flow rate may be increased up to 1.0 L/min, as long as there is no drawdown in the well. This method will not change the intended benefit of low flow sampling for VOCs and metals and it will reduce the total time required to fill the necessary sample jars.

1. With the water level indicator in the well, increase the flow rate. Select the flow rate that does not cause any increase in drawdown in the well.

2. Fill required bottles to the shoulder for semi-volatile compounds and PCB/pesticide analysis.

3. Immediately place the bottles in a cooler with ice.

VI. DOCUMENTATION

A. All sample collection activities will be documented in the field log book. The field log book will contain the following information:

1. Sampling location
2. Sample identification number
3. Date and time of collection
4. Depth to water
5. Purging rate and approximate volume purged

6. Field parameter measurements
7. Field observation (weather, odor, sheen, etc.)
8. Name of sampling personnel
9. Analyses requested

B. The Chain-of-Custody (COC) record will be used to document the samples taken and analyses requested. The COC record(s) initiated in the field will be signed, placed in a plastic "zip-lock" bag, and secured inside of the shipping container used for sample transport. Signed air bills will serve as evidence of custody transport between the field sampler and courier as well as the courier and laboratory. Copies of the COC record and the air bills will be retained and filed by the sampler prior to shipment. Information that field personnel will record on the COC record includes the following:

1. Project name
2. Sampling location
3. Printed name and signature of sampler
4. Date and time of collection
5. Sample designation (QA/QC, grab or composite)
6. Sample matrix
7. Number of containers
8. Analyses requested
9. Signature of individual involved with custody transfer, including date and time of transfer.

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SPECIFIC OPERATING PROCEDURE
AMERICAN CHEMICAL SERVICE NPL SITE
GRIFFITH, INDIANA

MONITORING WELL INSTALLATION

Developed: April 18, 2001 Approved: June 26, 2002

Scope and Application: This procedure is applicable for installation of monitoring wells at the ACS NPL Site, for use in groundwater level measurement and groundwater monitoring in the Long-Term Groundwater Monitoring Plan. All installation procedures are in compliance with 312 Indiana Administrative Code 13-8-3, ASTM D5092-90, and ASTM D1452-80.

Method: Monitoring wells, unless otherwise noted, will be installed using standard hollow-stem auger (HSA) methods. The general installation sequence will be 1) log the borehole from split-spoon sampling to determine screen interval, and 2) construct and install well.

I. INSTALLATION OF MONITORING WELL

There is potential for both upper and lower aquifer monitoring wells to be installed for the Long-Term Monitoring Plan. Lower aquifer monitoring wells involve first the installation of an outer casing to seal off the upper aquifer from the lower aquifer. Apart from the casing, the procedures for installing a monitoring well in the upper or lower aquifer are similar. The methods for installing monitoring wells are described below, starting with the installation of an outer casing for a lower aquifer well.

A. SETTING CASING (for lower aquifer wells)

1. This method is applicable for sealing off the upper aquifer from the lower aquifer while drilling through a confining layer. Unless the top of the confining layer is accurately known, it will be necessary to collect split-spoon samples until the clay layer is reached.

2. The upper portion of the borehole down to the confining layer will be drilled using 8¼- to 10¼-in. inner-diameter (ID) hollow stem augers (HSA).

3. Install the 8-in. (or other appropriate size) steel casing through the augers and advance it at least 2 feet into the confining layer.

4. Grout casing in place using neat cement (cement/bentonite slurry), from the base of the borehole up, using tremie pipes if possible, as the augers are slowly removed.

5. Allow the grout to set up for a minimum of 24 hours before drilling into the lower aquifer.

B. BOREHOLE DRILLING (for lower and upper aquifer wells)

1. The monitoring well will be installed using standard HSA methods. If there are flowing sand conditions, potable water will be introduced to assist in HSA drilling. If necessary, rotary wash drilling methods may be used. All drilling fluids will consist of potable water. All reasonable efforts will be made to drill through the planned screen depth without using a drilling additive.

2. If necessary, the drilling fluid will be circulated through the casing which will lift the cuttings in the annular space between the casing and borehole to the ground surface. A flow guide will be installed at the ground surface to direct the cuttings to a baffled tank (mudpan) where the cuttings will settle out. The drilling fluid will then be recirculated, to the extent possible.

3. Drilling will proceed (through the surface casing if a lower aquifer well) until the target depth is reached. Overdrilling, or drilling beyond the target depth, may be required to permit well installation at the desired depth, depending on whether flowing sand conditions are encountered.

C. WELL INSTALLATION (for lower and upper aquifer wells)

Unless otherwise noted, all monitoring wells will be constructed of two-inch diameter stainless steel material and fitted with a ten-foot stainless steel screen. All screens will be slotted with an 0.010-in. machine-cut slot, and have threaded joints. All risers will also be stainless steel with threaded joints.

1. Before Well Installation

   - Inspect screen and riser pipe inside and out for cleanliness, defects, gouges, cracks: reject any failed pieces. Accurately measure length of screen and riser piece. Count the number of riser pieces to confirm accurate total length of well.

   - Inspect filter pack material: proper gradation, proper material, contaminant free, sufficient quantity.

   - Inspect bentonite: 100 percent Wyoming bentonite with no additives, proper size, sufficient quantity for placing well seal.

2. During Well Installation

- Determine depth of well placement as total length of assembled well string minus height of well string above or below ground surface. If possible, above-ground stick-up wells are preferred.

- For upper aquifer wells, the screen should be placed to intercept the water table. For lower aquifer wells, the screen should be placed at a shallow (total depth ~ 40 feet), medium (total depth ~ 70 feet), or deep (total depth ~ 100 feet) interval of the aquifer.

- Riser pieces should have water-tight joints: either neoprene gaskets or Teflon tape. Do not use glue or solvent cement.

- Install a temporary well cap to prevent any materials from falling into the well. Lower well string down into the casing to the predetermined depth. Verify that the well is at the required depth.

- Introduce filter pack sand in a slow, controlled manner. Slowly retract the casing surrounding the screen. For upper aquifer wells, the filter pack will extend from the well bottom to two feet above the screen. For lower aquifer wells, the filter pack will extend from the well bottom to two feet above the screen or to the bottom of the clay confining layer, whichever is less. Periodically use tape measure to check for bridging and to verify height of filter pack in comparison to the well screen.

- Construct bentonite seal by adding at least two feet of bentonite pellets (for upper aquifer wells) or 100% bentonite slurry (for lower aquifer wells) to the top of the sand filter pack. Record the type, size, and volume of sealant placed.

- Construct the annular space seal, which will extend from the top of the bentonite seal to approximately four feet below ground surface. Use bentonite chips for upper aquifer wells, or a thick bentonite slurry to fill the annular space above the bentonite sand pack seal. Use a side discharge tremie pipe to place bentonite slurry into the annulus from the bottom up. Pump the slurry until it flows full strength, undiluted, up and out through the top of the hole. Remove excess grout, if necessary, so that the top sets up approximately four feet below ground surface. Allow grout to set up for a minimum 24 hours. Add bentonite chips to accommodate any grout that has settled. Hydrate, if necessary. Record type and volume of annular seal materials used.

- Construct a ground surface seal. Measure the length of well protective cover. Set protective cover over two-inch well such that approximately two feet rises above ground surface. Add bentonite chips to annulus, if necessary, so that protective cover is supported. Concrete the protective cover in place. Do not place bentonite between the protective pipe and the well casing. Add filter pack sand to the annulus between the well casing and the protective cover. Fill to approximately six inches below the top of the well casing. Drill a weep hole into the side of the protective cover, approximately six inches above ground surface, to allow for water to escape.

D. *After Well Installation.*

Check for settlement of the ground surface seal; top off as necessary. Label the protective casing with the well number. Lock the protective cover with a padlock.

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SPECIFIC OPERATING PROCEDURE

AMERICAN CHEMICAL SERVICE NPL SITE
GRIFFITH, INDIANA

MONITORING WELL DEVELOPMENT

Developed: April 18, 2001 Approved: June 26, 2002

Subject: Monitoring Well Development

Method: Surge and Purge using submersible pump

Well development should not occur within 24 hours after well construction if annular space is grouted. Grout must set up prior to development.

I. FIELD CHECKLIST

A. Paperwork to take to the site

1. Completed monitoring well construction summary for the wells to be developed
2. Monitoring well development summary forms
3. Health and Safety Plan

B. Equipment to take to the site

1. Field Notebook
2. Plastic sheeting
3. Electronic water level indicator
4. 5 gallon buckets
5. Plan for disposal of water
6. Decon solutions
7. Water quality meter (temp, pH, turbidity, etc.)
8. Pumps or bailers
9. Hand tools (socket set, hammer)
10. Well access (keys, flushmount access, off-site property access agreement)

II. WELL DEVELOPMENT

A. Place plastic sheeting around well to prevent potentially contaminated water from spilling onto ground.

B. Measure depth to water and total depth from top of the well casing with an electronic water level indicator. Record in field book.

C. Calculate the total volume of water contained in the well plus the volume of water in the sand pack:

Total Volume = well volume + sand pack volume
Well Volume (gallons) = 0.16(r2)(L)
Where r = inside well radius in inches
L = length of water column in feet

Sand Pack Volume (Gallons) = 0.057(R2-r2)L
Where R = borehole radius in inches
r = outside well radius in inches
L = saturated length of sand pack in feet
(assumes sand pack porosity of 35%)

D. Alternately surge and purge the well using a PVC/stainless steel bailer or submersible pump. Let the bailer or pump sink to the well bottom. Forcefully pull it up through the screen length and let it settle back to the bottom. This agitation suspends sediment in the well bottom and moves fines in and out of the well screen. If using a bailer, pull out the bailer and discharge the water into a 5 gallon bucket. If using a submersible pump, allow the pump to purge water into a 5 gallon bucket during the surging process. Note the color, odor, and general turbidity of the purge water in the field notebook. Repeat this surge and purge cycle for about 20-30 minutes.

E. After surging and purging for 20-30 minutes, continue to purge the well using a submersible pump or bailer. A submersible pump will be used if a sustainable flow rate from the well can be achieved. If the well is purged dry, a pump or bailer may be used for development. A well which purges dry is one that can be pumped down to the bottom and does not recover 50% of the well volume within 30 minutes.

F. For wells that cannot be purged dry, the purge water will be tested for pH, specific conductivity, temperature, and turbidity at regular volume intervals. If, after purging five well and sand pack volumes from the well, the readings of pH, specific conductivity, temperature, and turbidity are stabilized within 10% over three consecutive measurements, well development will be completed for the well. If parameter measurements have not stabilized within 10%, purging will continue until either stabilization has been achieved or a maximum of 10 well and sand pack volumes have been removed from the well.

G. For wells that purge dry, slowly purge the well using a pump or bailer. The purge water will be tested for pH, specific conductivity, temperature and turbidity at the end of each well plus sand pack volume. If possible, three to five well and sand pack volumes will be removed. Return trips to the well on the same day, or overnight may be necessary.

III. MANAGEMENT OF DEVELOPMENT WATER

A Purge water will be contained by pumping purge water into 5-gallon buckets or a plastic holding tank located on the back of a pick up truck. Upon completion of the development process, the water will be transported to the Montgomery Watson treatment plant for treatment and discharge to the wetland.

IV. EQUIPMENT DECONTAMINATION

A Development equipment (bailer, submersible pump, pump tubing) will be decontaminated between monitoring wells as follows:

- Wash with water and nonphosphate detergent (Alconox)
- Rinse with distilled water

B. Water generated during decontamination will be collected and transported to the treatment plant where it will be processed and discharged.

V. DOCUMENTATION

A. Monitoring Well Development Summary

1. Record method of surging and purging, time spent developing and total volume purged into field notebook.

2. Record time, pH, specific conductivity, temperature, and turbidity measurements into field notebook.

3. For wells where development was conducted with a submersible pump, record the maximum pumping rate used.

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SPECIFIC OPERATING PROCEDURE

AMERICAN CHEMICAL SERVICE NPL SITE
GRIFFITH, INDIANA

ABANDONMENT OF MONITORING WELLS

Developed: April 18, 2001 Approved: June 26, 2002

Scope and Application: This procedure is applicable for the abandonment of monitoring wells at the ACS NPL Site, for the purposes of the Long-Term Groundwater Monitoring Plan. All abandonment procedures are in compliance with 312 Indiana Administrative Code (IAC) 13-10-2 (e) (6) under *Wells abandoned after December 31, 1987.*

Method: Monitoring wells will be abandoned using standard hollow-stem auger (HSA) methods. The general abandonment sequence will be 1) plug the well, and if necessary, 2) drill out the previous well casing and grout the entire borehole from the bottom up. There is potential for both upper and lower aquifer monitoring wells to be abandoned for the Long-Term Groundwater Monitoring Plan. Abandonment procedures for lower aquifer wells are described in Section I, and procedures for upper aquifer wells are described in Section II.

I. LOWER AQUIFER WELL ABANDONMENT

A. Prior to any drilling, the well will be plugged with an impervious grouting material to prevent the migration of materials or fluids in the well and the loss of pressure in a confined aquifer. The plugging material must consist of one of the following: neat cement (≤5% bentonite additive), bentonite slurry, or bentonite pellets or chips. The neat cement and bentonite slurry will be introduced using a tremie pipe (½ inch ID PVC pipe) from the bottom of the well up. Bentonite chips or pellets will be introduced in such a way to ensure that bridging does not occur. The protective stick-up or flush-mount cover will then be removed.

B. If it is known that the outer casing is not a potential pathway for contaminants to the lower aquifer, then the well and casing shall be severed at or below the ground surface. If possible, the ground surface will be returned to conditions prior to well installation. Depending on the location, the abandoned well may be covered with a cement or asphalt plug, or covered with natural soils and/or sand and gravel.

C. If the outer casing is a potential pathway, then an additional outer casing will need to be installed to ensure that the upper aquifer is sealed off from the lower aquifer. An eight-inch ID (or other appropriate diameter) steel casing will be installed to a depth of two feet into the upper confining clay layer and grouted in place to seal off the upper aquifer from the lower aquifer. Grout will also be added to the inside of the outer casing and the abandoned well will be completed as in Step B above.

II. UPPER AQUIFER WELL ABANDONMENT

A. The well will first be plugged with an impervious grouting material to prevent the migration of materials or fluids in the well and the loss of pressure in a confined aquifer. The plugging material must consist of one of the following: neat cement (≤5% bentonite additive), bentonite slurry, or bentonite pellets or chips. The neat cement and bentonite slurry will be introduced using a tremie pipe (½ inch ID PVC pipe) from the bottom of the well up. Bentonite chips or pellets will be introduced in such a way to ensure that bridging does not occur.

B. The protective stick-up or flush-mount cover will be removed. The well shall be severed at or below the ground surface, and if possible, the ground surface will be returned to conditions prior to well installation. Depending on the location, the abandoned well may be covered with a cement or asphalt plug, or covered with natural soils and/or sand and gravel.

III. REPORTING

A. Per the Indiana Code, all well abandonment activity will be reported to the Indiana Dept. of Natural Resources, Division of Water, within 30 days by writing.

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APPENDIX B

FIELD FORMS

Water Level Measurement Form
Soil Boring Log
Monitoring Well Development Form
Monitoring Well Sheet

DATE: ____________________

Upper Aquifer Monitoring Wells

Well Designation	Reference Points East	North	TOIC	DTW	Initials	Notes and Observations
MW6	5298	5520	655.28			
MW11	6377	7329	640.47			
MW12	6019	6352	642.74			
MW13	5050	7814	634.08			
MW14	4882	6995	638.56			
MW15	4721	5003	637.89			
MW17	5656	5677	647.10			
MW19	5231	4943	635.78			
MW37	5395	7976	636.78			
MW38	5903	8216	636.51			
MW39	6253	7947	637.77			
MW40	6349	6831	639.46			
MW41	6242	4517	632.74			
MW42	6264	3808	632.32			
MW43	5880	3719	633.56			
MW44	5390	4303	633.04			
MW45	5830	4388	635.35			
MW46	4526	7424	633.32			
MW47	5958	5084	640.54			
MW48	5669	7814	636.36			
MW49	5551	7650	637.00			
M4S	4953	6537	633.42			

Staff Gauges & Piezometers

Staff Designation	Reference Points East	North	TOC	DTW	Initials	Notes and Observations
P13	4878	5735	651.20			
P17	4584	6006	654.64			
P23	4689	7018	636.18			
P25	5131	7510	635.01			
P26	4764	7309	634.23			
P27	4904	7020	639.70			
P28	5883	7486	644.53			
P40	5931	7241	638.77			
P41	5663	7377	637.23			
P49	5145	6949	638.98			
SG8R	5409	5252	634.70			
SG5	5464	7713	633.36			
SG13						To be installed
SG14						To be installed

DATE: ____________________

PGCS Piezometer Sets

Well Designation	Reference Points			DTW	Initials	Notes and Observations
	East	North	TOC			
P81	5577	7581	636.19			
P82	5577	7572	635.77			
P83	5577	7562	635.95			
P84	5322	7603	634.35			
P85	5326	7594	634.08			
P86	5329	7585	634.41			
P87	5121	7466	633.88			
P88	5130	7460	633.90			
P89	5137	7454	634.02			
P90	4881	7152	632.59			
P91	4889	7145	632.97			
P92	4896	7138	633.63			

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DATE: ____________________

BWES Water Level and Piezometer Pairs

Well Designation	Reference Points East	North	TOC	DTW	Initials	Notes and Observations
P31	5480	7159	641.03			
P32	5746	7026	642.32			
P36	5410	6851	645.89			
P93	5136	7067	638.79	DNE		To be replaced in 2002
P94	5146	7061	638.98	DNE		To be replaced in 2002
P95	5146	6532	638.58			
P96	5156	6537	638.39			
P105	5885	6678	638.86			
P106	5871	6685	638.10			
P107	5766	7339	637.42			
P108	5757	7324	638.13			
P109	5740	6387	644.30			
P110	5705	6382	647.68			
P111	5551	5950	650.03			
P112	5525	5960	653.36			
P113	5309	5693	657.53			
ORCPZ102	5331	5612	652.47			
P114	5035	5729	653.69			
P115	4970	5708	652.50			
P116	5031	6087	646.26			
P117	5014	6087	643.93			
P118	5402	6539	645.52			

Lower Aquifer Wells

Well Designation	Reference Points East	North	TOIC	DTW	Initials	Notes and Observations
MW7	6113	6732	641.46			
MW8	5934	7506	640.43			
MW9R	4893	6990	639.05			
MW10C	5229	7554	637.45			
MW23	4717	7404	633.31			
MW24	4596	8033	635.22			
MW28	5657	5695.6	648.77			
MW50	5269	5383	649.43			
MW51	5198	7767	634.16			
MW52	4996	7814	632.74			
MW54R	5589.8	7592.2	637.51			
M4D	4949	6538	633.32			

DTW = Depth to Water measurement

CAS/cas
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MONTGOMERY WATSON

SOIL BORING LOG

Facility/Project Name
ation

Boring No.
Project No.

Drilling Company
Driller's Name
Driller's Helper
Drill Method

State Plane N, E
Local Grid Location ft ☐ N ☐ S ft ☐ E ☐ W
1/4 of 1/4 of Section , T N,R E/W

Water Level
Sample Hammer Torque
Surface Elevation
Borehole Diameter at Screen

Logger
Editor
Start Date
End Date

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample	N Value	VISUAL CLASSIFICATION	Penetrometer (Tons/sq. ft.)	PID	% Gravel-Sand-Fines	Remarks
					5		5			
					10		10			
					15		15			
					20		20			
					25		25			
					30		30			
					35		35			

MONTGOMERY WATSON

MONITORING WELL DEVELOPMENT FORM

Project Name ______________________ Well No. ______________
Location ______________________ Project No. ______________
Developed By ______________________ Checked By ______________

1. Can this well be purged dry? ☐ Yes ☐ No
2. Well development method
   - surged with bailer and bailed ☐
   - surged with bailer and pumped ☐
   - surged with block and bailed ☐
   - surged with block and pumped ☐
   - surged with block, bailed and pumped ☐
   - compressed air ☐
   - bailed only ☐
   - pumped only ☐
   - pumped slowly ☐
   - Other ______________ ☐
3. Time spent developing well ________ min.
4. Total well depth (TOC) ________ ft.
   (From well construction summary)

   Measured well depth (Before) ________ ft.

   Measured well depth (After) ________ ft.
5. Inside diameter of well ________ in.
6. Volume of water in filter pack and well casing ________ gal.
7. Volume of water removed from well ________ gal.
8. Volume of water added (if any) ________ gal.
9. Source of water added ______________

		Before Development	After Development
10	Depth to Water (from top of well casing)	a. ________ ft.	________ ft.
	Date:	b. ________ mm dd yy	________ mm dd yy
	Time:	c. ________ ☐ a.m. ☐ p.m.	________ ☐ a.m. ☐ p.m.
11	Sediment in well bottom:	________ feet	________ feet
12	Water Observations:	Clear ☐ Turbid ☐ (Describe)	Clear ☐ Turbid ☐ (Describe)
	Color	________	________
	Odor	________	________
	Turbidity	________	________
	Other	________	________

Filter Pack Vol. (gallons) $(R^2-r^2)ls0.25$ = ________

Well casing Vol. (gallons) $0.16r^2 \times l$ = ________

Saturated length of sand pack (ft.) (ls) ________

Length of water column (ft.) (l) ________

R = Radius of borehole (in.) r = Well radius (in.)

Comments
____
____
____

Time	Gallons Purged	pH	Spec. Cond μS	Temp °C	Turbidity (NTU)	ORP	Odor	Color	DTW

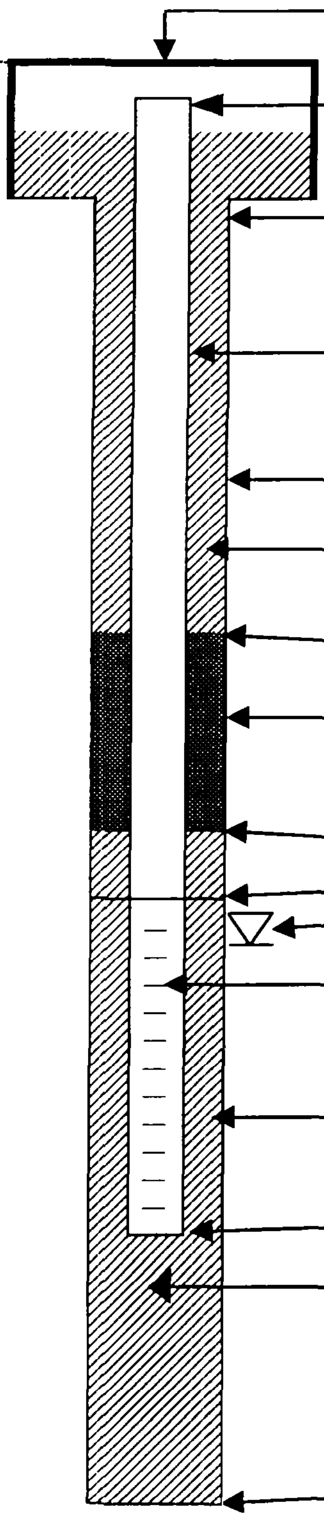
BORING NO. ____________

MONTGOMERY WATSON

MONITORING WELL SHEET

PROJECT ____________	LOCATION ____________	DRILLER ____________
PROJECT NO. ____________	BORING ____________	DRILLING METHOD ____________
ELEVATION ____________	DATE ____________	DEVELOPMENT METHOD ____________
FIELD GEOLOGIST Chad Smith		

GROUND ELEVATION



ELEVATION OF GROUND SURFACE: ____________

ELEVATION OF TOP OF WELL CASING: ____________

I.D. OF SURFACE CASING: ____________
TYPE OF SURFACE CASING: ____________

RISER PIPE I.D.: ____________
TYPE OF RISER PIPE: ____________

BOREHOLE DIAMETER: ____________

TYPE OF BACKFILL: ____________

DEPTH OF SEAL: ____________

TYPE OF SEAL: ____________

DEPTH TOP OF SAND PACK: ____________
DEPTH TOP OF SCREEN: ____________
FIRST ENCOUNTERED SATURATED ZONE ____________

TYPE OF SCREEN: ____________
SLOT SIZE x LENGTH: ____________
I.D. OF SCREEN ____________

TYPE OF SAND PACK: ____________

DEPTH BOTTOM OF SCREEN: ____________

DEPTH BOTTOM OF SAND PACK: ____________
TYPE OF BACKFILL BELOW OBSERVATION WELL: ____________

DEPTH OF HOLE: ____________

APPENDIX C

SITE SAFETY PLAN ADDENDUM

SITE SAFETY PLAN ADDENDUM
LONG-TERM GROUNDWATER MONITORING PLAN

AMERICAN CHEMICAL SERVICE, INC.
NPL SITE
GRIFFITH, INDIANA

MWH File No.: 2090603

Prepared For:

ACS RD/RA Executive Committee

Prepared By:

**MWH, Inc.
27755 Diehl Road, Suite 300
Warrenville, Illinois 60555**

September 2002

SITE SAFETY PLAN ADDENDUM
LONG-TERM GROUNDWATER MONITORING PLAN

AMERICAN CHEMICAL SERVICE, INC.
NPL SITE
GRIFFITH, INDIANA

MWH File No.: 2090603

Prepared For:

ACS RD/RA Executive Committee

Prepared By: ______________________ September 20, 2002
Chad A. Smith, P.G. Date
Professional Hydrogeologist

Approved By: ______________________ Sept 20, 2002
Peter J. Vagt, Ph.D., CPG Date
Vice President

EMERGENCY INFORMATION

Emergency Phone Numbers
(Nearest phone inside MWH Treatment Building)

Ambulance	911
Poison Control	(800) 382-9097
Police	911
Fire	911
State Highway Patrol	(800) 552-8917
IDEM Emergency Response	(888)-233-7745
EPA Region 5 Spill Response	(312) 353-2318

Nearest Phone, First Aid Kit, Fire Extinguisher, and Eye Wash Station	MWH Treatment Building
Nearest Hospital	Munster Community Hospital 901 McArthur Boulevard Munster, Indiana (219) 836-1600 (219) 836-4511 (emergency room)

Project Contacts

MWH

Project Coordinator (PC)	Joseph Adams, Jr.	(303) 410-4040
Health & Safety Coordinator (HSC)	Travis Klingforth	(630) 836-8900
Site Safety Officer (SSO)	Lee Orosz	(219) 924-4607
Project Manager	Peter Vagt	(630) 836-8900

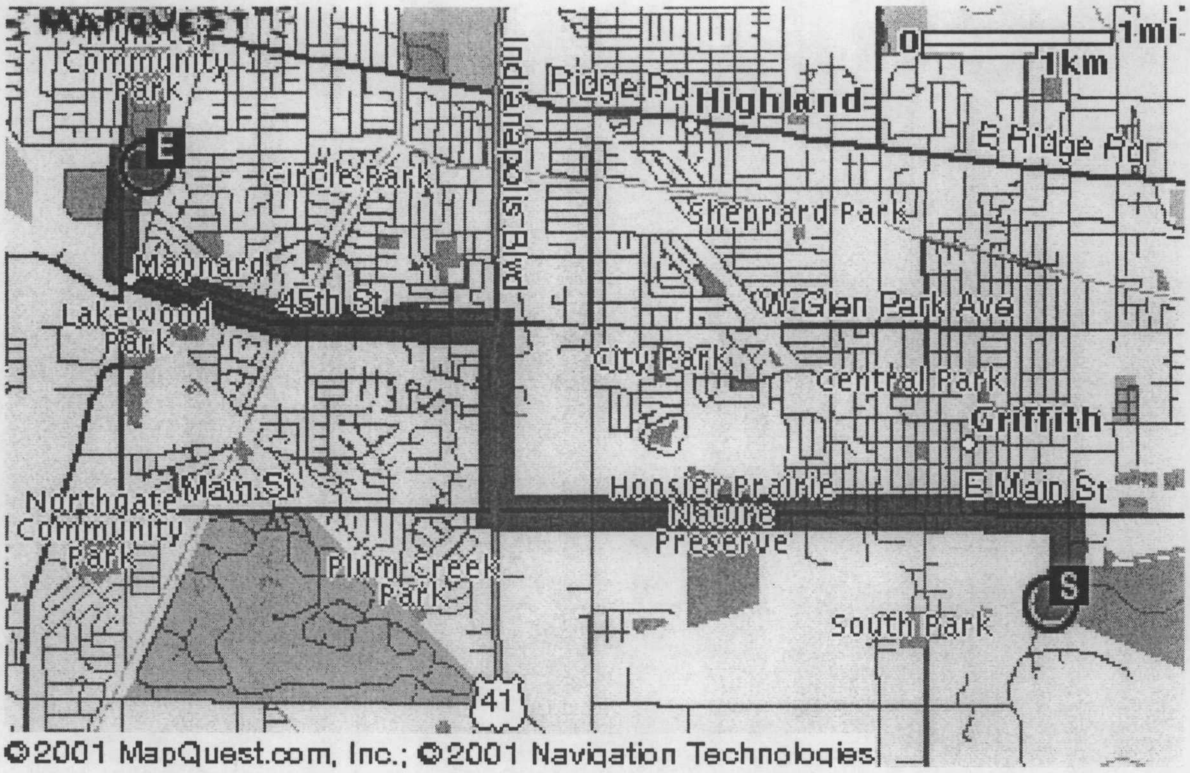
Regulatory Agencies

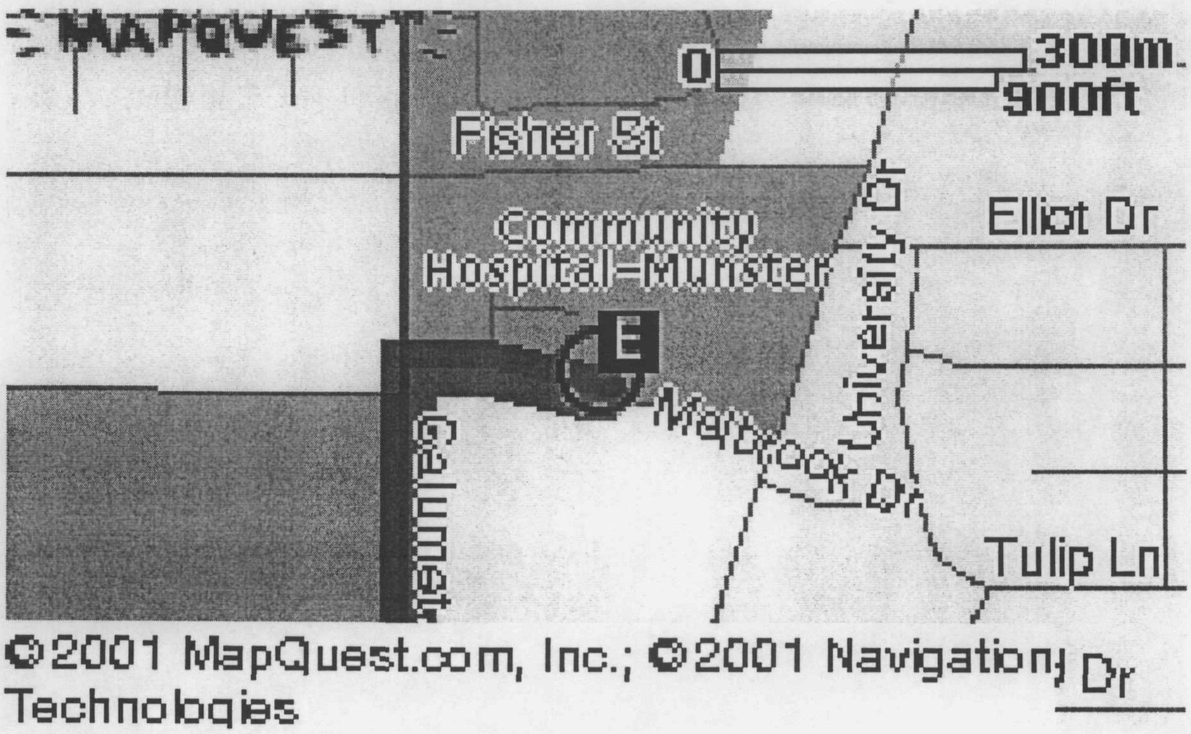
U.S. EPA Remedial Project Manager	Kevin Adler	(312) 886-7078
IDEM Project Manager	Prahbhakar Kasarabada	(317) 308-3121

Utilities

Utility Locate	IUPPS	(800) 382-5544
Telephone	Ameritech	(800) 636-1200
Gas/Electric	NIPSCO	(800) 634-3524
Water/Sewer	Griffith Public Works	(219) 924-3838

Directions to hospital: Exit ACS Site onto Colfax and go north to Main Street. Turn left onto Main Street and head west to Indianapolis Boulevard (Route 41). Turn right onto Route 41 and go north to 45th Street. Turn left onto 45th Street go west to Calumet Avenue. Turn right onto Calumet Avenue, and go north about 0.6 miles. Follow signs to the hospital emergency entrance, which is on the east side of street.





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APPENDICES

ACRONYMS AND ABBREVIATIONS

ACS	American Chemical Service, Inc.
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
BWES	Barrier Wall Extraction System
CPR	Cardiopulmonary Resuscitation
dB	decibels
°F	Fahrenheit
FSP	Field Sampling Plan
HSC	Health and Safety Coordinator
HSM	Health and Safety Manager
IDEM	Indiana Department of Environmental Management
IDW	Investigative-Derived Waste
IUPPS	Indiana Underground Plant Protection Service, Inc.
MSDS	Material Safety Data Sheet
MWH	Montgomery Watson Harza
NIPSCO	Northern Indiana Public Service Company
NPL	National Priorities List
PC	Project Coordinator
PCB	polychlorinated biphenyl
PPE	personal protection equipment
PGCS	Perimeter Groundwater Containment System
PID	photo-ionization detector
Predesign SSP	Predesign Site Investigation Site Safety Plan
OSHA	Occupational Health and Safety Administration
RD/RA	Remedial Design/Remedial Action
SVOC	Semi-Volatile Organic Compound
SSO	Site Safety Officer
SSP	Site Safety Plan
U.S. EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

This Site Safety Plan (SSP) Addendum addresses health and safety procedures during all activities associated with the revised Long-Term Groundwater Monitoring Plan (the Plan) conducted at the American Chemical Service, Inc. (ACS) National Priorities List (NPL) Site. The procedures established in this SSP will minimize potential risk to MWH, Inc. (formerly Montgomery Watson) personnel performing on-site work. This SSP Addendum should be used in conjunction with the Predesign Site Investigation SSP (Predesign SSP) dated January 1996.

The Predesign SSP and this SSP Addendum apply to all MWH employees who will potentially be exposed to safety and/or health hazards associated with the field activities related to the Plan. Subcontractors may be requested to provide their own SSP, which at a minimum, must comply with the requirements of the Occupational Safety and Health Administration (OSHA) Hazardous Waste Operation and Emergency Response Standards (29 CFR 1910.120) and other applicable OSHA regulations. This SSP Addendum has been developed based on knowledge of the specific chemical hazards and potential physical hazards associated with the Plan's activities, which include water level measurement, groundwater sampling, and possibly monitoring well, piezometer, and staff gauge abandonment or installation.

The Predesign SSP and this SSP Addendum have been prepared in compliance with the requirements of the OSHA Hazardous Waste Operation and Emergency Response Standards (29 CFR 1910.120) and other applicable OSHA regulations. Actual working conditions may require modification of this SSP Addendum. Except for minor modifications or in emergency situations, the MWH Health and Safety Manager (HSM) or local Health and Safety Coordinator (HSC) must approve any modifications before they can be implemented. Written documentation of the change must be attached as additional addenda to this SSP Addendum.

2.0 SITE DESCRIPTION AND SCOPE OF WORK

2.1 SITE DESCRIPTION

The ACS Site is located at 420 South Colfax Avenue in Griffith, Indiana. The facility began as a solvent recovery facility in 1955, with some chemical manufacturing operations beginning in the late 1960's. Detailed site descriptions are provided in Section 2.0 of the Predesign SSP, or various other reports.

2.2 SCOPE OF WORK

Based on five years of groundwater data, a revised Plan has been developed to evaluate remedial measures carried out at the Site. The activities required by this revised Plan include the following tasks:

- Collecting water levels from several upper and lower aquifer gauging points;
- Collecting groundwater samples from several upper and lower aquifer monitoring wells, as well as from several nearby residential wells; and
- Potential for abandonment or installation of monitoring wells, piezometers, or staff gauges.

3.0 GENERAL SITE HEALTH AND SAFETY CONSIDERATIONS

This section describes general health and safety concerns not associated with specific tasks to be accomplished at the Site.

3.1 WEATHER CONDITION RESTRICTIONS

Since weather conditions on Site cannot be controlled, Site personnel are to be aware of the warnings of impending severe weather and the precautions that are to be taken. Thunderstorms, tornadoes, and winter storms can develop quickly, and jeopardize the safety of Site personnel. Should severe weather threaten, the Site Safety Officer (SSO) has the authority to place site activities on standby, to cease operations, and evacuate the Site as deemed necessary. The following procedures are to be followed in the event of severe weather

Thunderstorms and Lightning

- Monitor weather conditions at all times. Check the weather forecast at the beginning of each day for the latest weather information.

- When a thunderstorm accompanied by lightning is in the project area, cease work immediately. All powered equipment, such as drill rigs, are to be shut down. Wait at least 15 minutes after the last lightning strike to continue work..

- Seek shelter inside nearby buildings or trailers. If there are no buildings nearby, stay inside a vehicle. If away from any form of shelter, do not stand beneath tall, isolated trees or telephone poles. Avoid hill tops, open water, metal equipment, wire fences and metal pipes.

- If you are caught in a level field or open area far from shelter, and you feel your hair stand on end, lightning may be about to strike you. Drop to your knees and bend forward, putting your hands on your knees. You should minimize the body area in direct contact with the ground, and avoid lying flay on the ground.

- If someone has been struck by lightning, monitor life signs and begin administering Cardiopulmonary resuscitation (CPR) as needed. Send for help. Check conscious victims for burns, especially at the fingers and toes and next to knuckles and jewelry. Administer first aid for shock. Do not let the victim walk around.

Tornadoes

- Tornadoes usually develop from thunderstorms and normally occur at the trailing edge of the storm. Most tornadoes occur in the months of April, May, June, and July in the late afternoon and early evening hours.

- When storms are predicted for the project area, monitor weather conditions on a radio. A tornado watch is issued when favorable conditions exist for the development of a tornado, a tornado warning is issued by the local weather service office whenever a tornado has actually been sighted.

- If a tornado warning is issued, seek shelter immediately. If there are permanent buildings, go there immediately, moving towards interior hallways or the lowest floor. If no shelter is nearby, lie flat in a ditch or depression and hold onto something on the ground, such as a bush or fence post.

- Once a tornado has passed the Site, Site personnel are to assemble at the MWH treatment building immediately to determine if anyone is missing. Administer first aid and seek medical attention as needed.

Winter Storms

- When snow or ice storms are predicted for the project area, Site personnel should monitor weather conditions on a radio. A winter storm watch is issued when a storm has formed and is approaching the area, and a winter storm warning is issued when a storm is imminent and immediate action is to be taken.

- When a storm watch is issued, monitor weather conditions and prepare to halt site activities. Notify the project manager of the situation. Seek shelter at site building or leave the site and seek warm shelter.

- If caught in severe winter weather while traveling, seek warm shelter if road conditions prevent safe travel.

- If stranded in a vehicle during a winter storm, stay in the vehicle, wait for help, and keep a window open an inch or so to avoid carbon monoxide. Run the engine sparingly to keep warm, and try to exercise occasionally.

3.2 TEMPERATURE STRESS

Since hot or cold weather cannot be controlled, site personnel need to be aware of engineering controls that can reduce temperature stress, the signs and symptoms of temperature stress and first aid measures for victims of temperature stress. The following procedures for temperature stress monitoring follows:

Cold Stress

- In general, if extreme cold temperatures exist (<0 °F), the continuance of work should be evaluated. Groundwater sampling may not be feasible at temperatures far below freezing.

- Reduction of cold temperatures can be achieved by spot heating: shielding work areas from wind, and using heated rest areas (including vehicles).

- Cold stress can be reduced by drinking warm drinks or soups frequently, using heated rest areas frequently, using the buddy system, and taking extra breaks as needed. Do not pressure someone to work beyond his or her capabilities.

- Reorganize work procedures so as much of a job can be done in a warm environment as possible.

- Remove wet clothing if possible.

- Send a worker to warm shelter immediately if any of the following symptoms are noted: heavy shivering, frostnip (skin turns white), feeling of excessive fatigue, drowsiness, euphoria.

- First aid: Take victim to a warm area and remove the outer layers of clothing. Gently warm the affected area, submerge in tepid water if possible. Do not rub. If there is evidence of frostbite, obtain medical attention immediately.

Heat Stress

- In general, if extreme hot temperatures exist (>100 °F), the continuance of work should be evaluated.

- Reduction of hot temperatures can be achieved by developing and adhering to a work-rest schedule and taking breaks in cool areas.

- Heat stress can be reduced by drinking cool fluids hourly, avoiding caffeine and alcohol, using the buddy system, and taking extra breaks as necessary. Do not pressure someone to work beyond his or her capabilities.

- Schedule work for the cooler parts of the day.

- If your heart rate exceeds 110 beats/minute at the beginning of a rest period, shorten the next work cycle by about 1/3. Also, you should not lose more than 1.5% of your total body weight in a day. If you do, drink fluids to compensate and prevent dehydration.

- Send worker to a cool shelter immediately if any of the following are noticed: heat rash, heat cramps (muscle spasms, pain in hands, feet or abdomen), heat exhaustion (pale, cool, moist skin; heavy sweating; dizziness; nausea; fainting), heat stroke (red, hot, usually dry skin; lack of perspiration; nausea; dizziness; confusion; strong, rapid pulse; coma).

- First aid: remove protective clothing and equipment and wrap the victim in wet towels or clothing. If there are signs of heat exhaustion or heat stroke, seek medical attention immediately.

3.3 HEAVY EQUIPMENT

Special safety procedures are required when working around operating heavy equipment. For the Plan, there is potential for working around heavy equipment, such as drill rigs. Hazards associated with operating heavy equipment include obstructed view, moving parts, overhead clearance, and noise. In general,

- Heavy equipment should be operated only by trained authorized personnel.
- Equipment should be inspected daily.
- Equipment should be equipped with backing alarms.
- Personnel working on the equipment or in the area should wear safety glasses, steel-toe safety boots, and hard hats.
- All safety switches must be operational.
- Drill rigs should remain at least 10 feet from overhead power lines and should not be moved with the boom raised.
- Non-essential personnel should remain a safe distance from these operations.

3.4 TRAFFIC

If personnel will be in a roadway or within 10 feet of a roadway during work activities, orange safety vests must be worn. Barricades and warning signs and/or cones may be required. The SSO will determine if additional measures are warranted and will implement necessary control measures. Always be aware of local traffic patterns, and exercise care when entering a road with a MWH vehicle.

3.5 BIOLOGICAL HAZARDS

There is potential for site personnel to come in contact with certain biological hazards

Biological - Occupationally induced infection can occur in any occupation as a result of exposure to bacteria, viruses, fungi, or parasites. A simple laceration from a sharp edge can become secondarily infected with staphylococci or streptococci. A thorn, a wood splinter, or a metal slug acting as a foreign body can pave the way for secondary infection of the skin. Cuts, scrapes, or other lacerations should be cleaned, disinfected, and dressed immediately following standard first aid procedures.

Plants – A broad variety of plants and wood cause injury to skin through primary irritation or allergic sensitization. Examples include poison ivy and sumac. Site personnel are required to wear long plants while at the Site. Contact with poisonous plants should be avoided. If skin contact is made with poisonous plants, the exposed area will be washed with soap and water followed by rubbing alcohol. Seek medical advice if severe reaction occurs.

Insects – Insect bites and stings can be serious to hypersensitive persons and even deadly depending on the type of insect. Examples include bees, wasps, hornets, brown recluse spiders, and ticks. Avoid tall grassy areas or other areas of thick vegetation. If work is performed in these areas, personnel should wear light colored clothing (for easy tick spotting) and a commercially available repellant, and check for ticks regularly.

Animals – Animal bites are a concern because of the potential for the animal to carry the rabies virus, which attacks the nervous system. If an animal bite occurs the victim must be taken to the nearest medical facility immediately.

3.6 UTILITIES

All utilities must be cleared before performing any intrusive activities, such as monitoring well installation. The SSO will verify that utilities have been cleared before work begins at the site. See Section 4.5 for further information on utility clearance.

3.7 NOISE

Hearing protection is required when working in close proximity to heavy equipment, such as drill rigs, if the level of noise interferes with communication or the sound level exceeds 85 decibels (dB). Hearing protection is required within 50 feet of the following operations:

- Driving the split spoon sampler
- During core drilling
- Using power tools
- Using air compressor

4.0 PROJECT-SPECIFIC HEALTH AND SAFETY PROCEDURES

4.1 KEY PERSONNEL AND RESPONSIBILITIES

Assignment of responsibilities for development, coordination and implementation of this SSP Addendum is essential for proper administration of the Plan's requirements. Implementation of the SSP Addendum will be accomplished through an integrated effort of the Project Coordinator (PC), Health and Safety Coordinator (HSC), and Site Safety Officer (SSO).

Project Coordinator – The PC is primarily responsible for safety performance of the project and is the central point of contact with the ACS Remedial Design/Remedial Action (RD/RA) Executive Committee. Should a health and safety issue develop in the performance of the field activities, the PC will contact the ACS RD/RA Executive Committee and the MWH HSC.

Health and Safety Coordinator – The HSC is responsible for preparation of the SSP Addendum. The HSC will ensure that the SSP Addendum complies with OSHA standards and site-specific health and safety requirements based on known or anticipated health and safety concerns. The HSC will be available for consultation when required. The HSC may visit the Site during field activities to perform a site safety audit.

Site Safety Officer – The SSO is responsible for the implementation of the SSP Addendum. The SSO has the responsibility and authority to halt or to modify any work condition or remove personnel from the Site if he or she considers conditions to be unsafe. The SSO will be the main contact in any Site emergency situation. The SSO will ensure that all MWH personnel understand and comply with site safety requirements. If necessary, the SSO can modify the SSP Addendum to accommodate changes that may affect safety. Except for minor changes or emergencies, the SSO will notify the HSC before modifying the SSP Addendum.

Field Staff – All MWH field staff are responsible for understanding and complying with all requirements of the Predesign SSP and this SSP Addendum. Every morning before the start of field activities, a tailgate safety meeting will be conducted by the SSO or field team leader to instruct the field staff on the day's activities as well as this SSP Addendum's requirements. During this meeting, site safety questions can be directed to the meeting leader by the field staff. Each worker must sign and date the Tailgate Safety Meeting Form stating that he or she understands the contents of the Predesign SSP and this SSP Addendum. The Tailgate Safety Meeting Form is attached in Appendix A.

4.2 SAFETY ISSUES OF CONCERN

The activities outlined in the Plan do not involve activities that pose severe hazards; however, as with any Site, caution must be taken to avoid the unexpected. The main activities include groundwater elevation monitoring, groundwater sampling, and possibly monitoring well installation or abandonment. The safety issues related to these activities are outlined below.

4.2.1 Chemical

Although a wide variety of potential substances of concern have been identified at the ACS Site, most of these are contained within the barrier wall. Other than measurement of water levels at a few locations inside the barrier wall, all other Plan activities take place outside of the barrier wall where concentrations of contaminants are significantly lower. Based on groundwater data collected over the past 5 years, volatile organic compounds (VOCs) are the compounds of concern in the groundwater surrounding the Site. Of the VOCs, halogenated and light aromatic hydrocarbons are the main VOCs of concern. Semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), pesticides, and inorganics have not been detected in groundwater at significant amounts around the Site.

The halogenated hydrocarbons are highly mobile, and migrate easily through water, air, and soil. They may act on the central nervous system, either as a stimulant or depressant. Mild exposure may cause such symptoms as dizziness, nausea, abdominal pain, and vomiting. In chronic (long-term) exposure, loss of weight and appetite may occur. Moderately severe exposure presents those symptoms given above followed by severe irritability, convulsive seizures, and coma. Compounds from this class of chemicals historically detected at the site include:

- Chloroethane
- 1,2-dichloroethane
- 1,1,1-trichloroethane
- Trichloroethane

Compounds in the light aromatic hydrocarbon group are highly volatile, moderately soluble, biodegradable, and only slightly adsorbed on soils and sediments. Their presence at the surface is based on volatilization rates and biodegradation activities. They are very mobile in groundwater. Exposure to these substances is primarily through vapor inhalation, although absorption through skin may also readily occur. Acute exposure poses the primary health hazard of these substances. Low level exposure may result in irritability, excitability, muscle tremor, and headache. Compounds from this class of chemicals detected at the site include:

- Benzene
- Toluene
- Ethylbenzene
- Xylene

Benzene and chloroethane are the main VOCs detected in groundwater around the Site. Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX) compounds have also been detected south of the ACS Site, near MW06 and the entrance to the Griffith Landfill. Other halogenated VOCs have been detected at very low amounts in other areas around the Site.

The Material Safety Data Sheet (MSDS) sheets for the representative compounds are presented in Appendix B.

4.2.2 Physical

General physical hazards at the ACS Site include common slip, trip, and fall hazards. Since many of the monitoring wells are located in the surrounding woods and wetlands, slip, trip, and fall hazards are abundant, especially in wet or damp conditions. Caution should be taken while walking through the woods to avoid leaf-covered areas that may be covering holes or branches. Several piezometers are also located on the ACS property. Hazards include large vehicle traffic and slip, trip, and fall hazards. While on the ACS property, caution should be taken to always be aware of surrounding activity.

4.2.3 Biological

General biological hazards at the ACS Site include insects, snakes, rodents, poisonous plants, and spider species. Occupationally induced infection can occur as a result of exposure to bacteria, viruses, fungi, or parasites. A simple laceration from a sharp edge can become secondarily infected with staphylococci or streptococci; thorn, wood splinter, or metal slug acting as a foreign body may cause secondary infection of the skin. Cuts, scrapes, or other lacerations should be cleaned, disinfected, and dressed immediately following standard first aid procedures.

4.2.4 General

No eating, drinking, use of tobacco products, including smoking or chewing, or other hand-to-mouth activities will be permitted in the work areas during the course of this project. Eating, drinking, smoking and break facilities, as well as the equipment storage and vehicle parking will be located in the Support Zones.

4.3 MONITORING

Due to the nature of the work proposed under the Plan, the only air monitoring activity will be of VOCs during subsurface drilling activities. Volatile organic compound monitoring will be completed by utilizing a photo-ionization detector (PID) with a lamp rating of 11.7 eV. If readings are consistently above 1 ppm, then Level C personal protection equipment (PPE) will be worn (See Section 4.4). Air monitoring will be performed during initial drilling activities and approximately every 15 minutes, or if odors are encountered in the soil cuttings. The monitoring results will be recorded in the field book. The PID will be calibrated at the beginning of each day, and will be performed per manufacturer's instruction.

4.4 PERSONAL PROTECTIVE EQUIPMENT

At a minimum, Level D PPE will be worn during Site activities. If Level C or Level B PPE is needed for groundwater monitoring activities, then the PPE procedures in the Predesign SSP will be followed, or a separate addendum will be prepared and submitted for approval.

A description of Level D PPE follows below:

Level D – Groundwater monitoring

- Work uniform
- Steel-toe boots
- Neoprene or Nitrile gloves
- Safety glasses*

Level D – Subsurface activities (monitoring well installation)

- Work uniform
- Steel-toe boots
- Neoprene or Nitrile gloves
- Hard hat
- Safety glasses
- Hearing protection*
- Latex boot covers*
- Tyvek*

* Optional PPE: use as needed

4.5 EMERGENCY INFORMATION

Prior to work startup, the SSO or field team leader will discuss the emergency medical assistance network at the Site with all personnel assigned to the field project. Locations of phones, fire extinguishers, first-aid kits, emergency telephone numbers, etc. will be identified. Unless otherwise noted, phones, fire extinguishers, and first-aid kits are all located at the MWH treatment building.

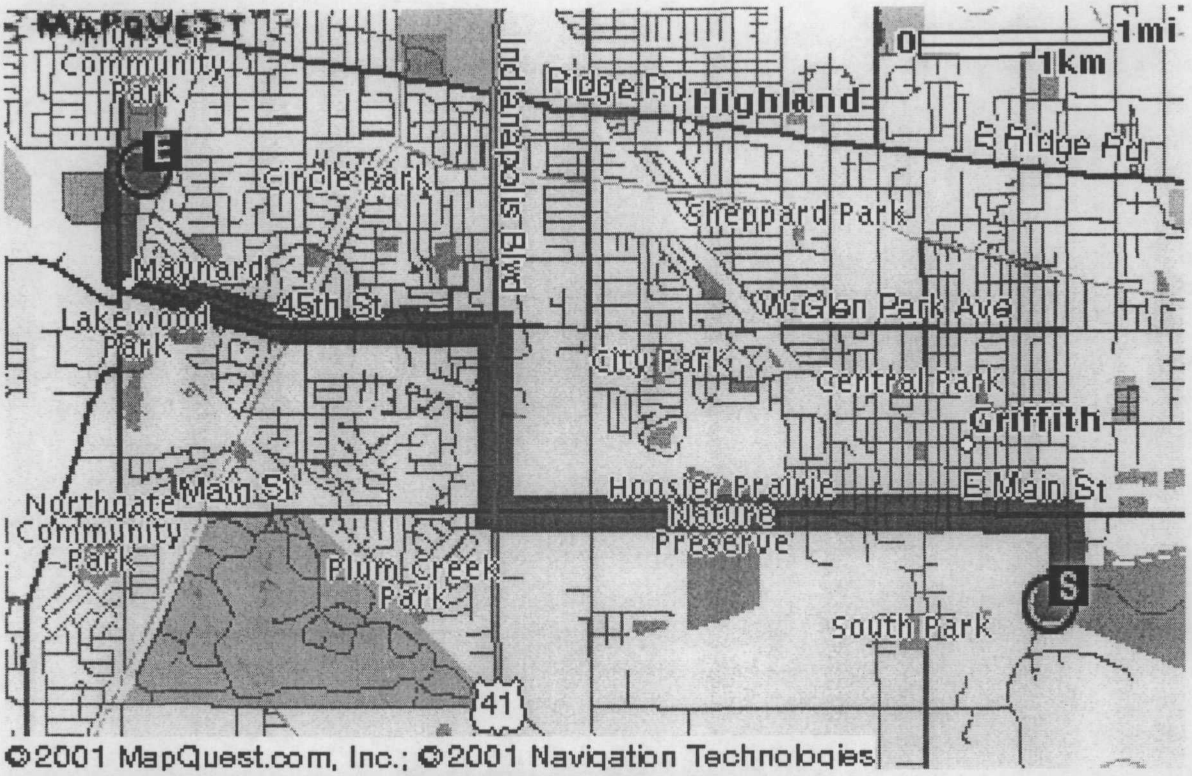
Emergency information is provided below and in the quick-reference sheet at the beginning of this document.

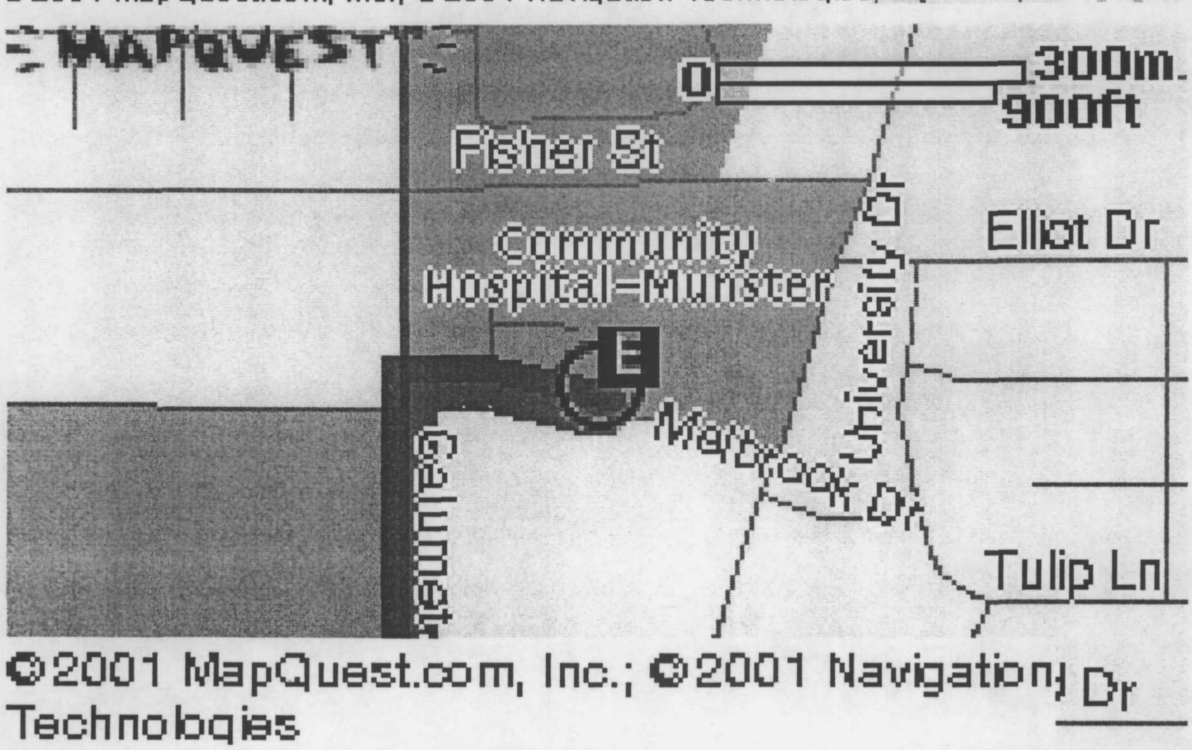
<u>Emergency Phone Numbers</u> (Nearest phone inside MWH Treatment Building)

Ambulance, Police, or Fire	911
Poison Control	(800) 382-9097
State Highway Patrol	(800) 552-8917
IDEM Emergency Response	(317) 233-7745
EPA Region 5 - Spill Response	(312) 353-2318

<u>Nearest Phone, First Aid Kit, Fire Extinguisher, and Eye Wash Station</u>	MWH Treatment Building
<u>Nearest Hospital</u>	Munster Community Hospital 901 MacArthur Boulevard, Munster, Indiana (219) 836-1600 (219) 836-4511 (emergency room)

Directions to hospital: Exit ACS Site onto Colfax and go north to Main Street. Turn left onto Main Street and head west to Indianapolis Boulevard (Route 41). Turn right onto Route 41 and go north to 45th Street. Turn left onto 45th Street go west to Calumet Avenue. Turn right onto Calumet Avenue, and go north about 0.6 miles. Follow signs to the hospital emergency entrance, which is on the east side of street.





Project Contacts

MWH

Project Coordinator	Joseph Adams, Jr.	(303) 410-4040
Health & Safety Coordinator	Travis Klingforth	(630) 836-8900
Site Safety Officer (SSO)	Lee Orosz	(219) 924-4607
Project Manager	Peter Vagt	(630) 836-8900

Regulatory Agencies

U.S. EPA Remedial Project Manager	Kevin Adler	(312) 886-7078
IDEM Project Manager	Prahbhakar Kasarabada	(317) 308-3121

Utilities

Utility Locate	IUPPS	(800) 382-5544
Telephone	Ameritech	(800) 636-1200
Gas/Electric	NIPSCO	(800) 634-3524
Water/Sewer	Griffith Public Works	(219) 924-3838

4.6 TASK SPECIFIC HAZARD EVALUATION

4.6.1 Monitoring Well Installation

Potential Hazards: VOCs, severe weather, temperature stress, heavy equipment, biological hazards, utilities, and noise.

Hazard Evaluation: Low to moderate

Principle Route of Chemical Exposure: Dermal contact and inhalation

Level of Protection: For monitoring well installation, Level D protection is applicable, since work is performed outside of high waste areas. If air monitoring indicates the presence of VOCs above 5 ppm, then upgrade to Level C will be performed.

Air Monitoring: For VOCs using a PID, during initial drilling activities and approximately every 15 minutes or when odor is encountered in the soil cuttings.

4.6.2 Groundwater Sampling and Groundwater Elevation Measurement

Potential Hazards: VOCs, severe weather, temperature stress, biological hazards, and slip/trip/fall hazards.

Hazard Evaluation: Low

Principle Route of Chemical Exposure: Dermal contact and inhalation

Level of Protection: Level D protection is applicable for these activities.

Air Monitoring: None.

4.7 DECONTAMINATION

4.7.1 Personal

All safety gloves will be disposed of in the appropriate container. If gloves or other clothing is grossly contaminated, it will be cleaned prior to disposal. All decontamination water will be collected and disposed of at the MWH treatment building. Prior to snack or lunch breaks, each person should thoroughly wash his or her hands and face in soap and water. At the end of each day, each person involved in Site activities should shower as soon as possible.

4.7.2 Equipment

Decontamination of all sampling and measurement equipment, as well as heavy equipment, such as a drill rig, will be conducted in accordance with Section 4.5 of the Field Sampling Plan (FSP). In general, field and sampling equipment will be washed between sampling locations with a detergent wash, and the drilling equipment will be decontaminated using a steam pressure wash. All decontamination water will be collected for treatment at the MWH Treatment Plant.

4.8 INVESTIGATIVE DERIVED WASTE

Anticipated Investigative Derived Wastes (IDWs) to be generated during the Plan's activities include liquids, solids, and general refuse. Liquid IDW includes groundwater collected during purging or developing during groundwater sampling, and decontamination wash and rinse water. All liquid IDW will be disposed at the MWH treatment plant, where it will be treated and discharged to the wetlands. Prior to the completion of the cap, solid IDW, such as soil cuttings generated during drilling activities, will be disposed within future ISVE areas. After the final cap is complete, MWH will arrange for proper off-site disposal of any solid IDW. General refuse IDW includes disposable sampling equipment and PPE, such as disposable nitrile gloves. This material will be placed in trash bags and disposed of as solid waste at a local landfill, as long as it is not grossly contaminated. Grossly contaminated refuse will be disposed of in the same manner as solid IDW.

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APPENDIX A

TAILGATE SAFETY MEETING FORM

TAILGATE SAFETY MEETING FORM

Date: ____________ **Time:** ___________

Scope of Work: ____
____

Safety Topics Covered

Chemical Hazards:	VOCs (benzene, chloroethane)	________
Physical Hazards:	Equipment	________
	Utilities	________
	Temperature stress	________
	Traffic	________
	Trip, slip, fall	________
	Weather conditions	________
PPE:	Review of Level D	________
Special Equipment:		________
Decontamination:		________
Other:	No smoking, eating or drinking in work areas	________
Emergency Procedures:	Review location of first aid kit, etc.	________
	Hospital route	________

Name Printed	**Signature**
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________

Meeting Conducted by: ____

APPENDIX B

MATERIAL DATA SAFETY SHEETS

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 312
Trichloroethylene

Issued: 7/79 Revision: F, 9/92

Section 1. Material Identification 39

Trichloroethylene (C_2HCl_3) Description: Derived by treating tetrachloroethane with lime or other alkali in the presence of water, or by thermal decomposition of tetrachloroethane followed by steam distillation. Stabilizers such as epichlorohydrin, isobutanol, carbon tetrachloride, chloroform, benzene, or pentanol-2-triethanolamine are then added. Used as a degreasing solvent in electronics and dry cleaning, a chemical intermediate, a refrigerant and heat-exchange liquid, and a diluent in paint and adhesives; in oil, fat, and wax extraction and in aerospace operations (flushing liquid oxygen). Formerly used as a fumigant (food) and anesthetic (replaced due to its hazardous decomposition in closed-circuit apparatus).
Other Designations: CAS No. 79-01-6; acetylene trichloride; Algylen; Anamenth; Benzinol; Cecolene; Chlorylen; Dow-Tri; ethylene trichloride; Germalgene; Narcogen; Triasol; trichloroethene; TCE; 1,1,3-trichloroethylene.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 2
S 2*
K 3
* Skin absorption

NFPA: 2, 2, 0, -

HMIS
H 2†
F 2
R 0
PPE‡
† Chronic Effects
‡ Sec. 8

Cautions: TCE is irritating and toxic to the central nervous system (CNS). Inhalation of high concentrations have lead to death due to ventricular fibrillation. Chronic exposure may lead to heart, liver, and kidney damage. The liquid is absorbed through the skin. Although it has a relatively low flash point, TCE burns with difficulty.

Section 2. Ingredients and Occupational Exposure Limits

Trichloroethylene, < 100% [contains stabilizers (Sec. 1)].

1991 OSHA PELs
8-hr TWA: 50 ppm (270 mg/m^3)
15-min STEL: 200 ppm (1080 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH REL
10-hr TWA: 25 ppm (~135 mg/m^3)

1992-93 ACGIH TLVs
TWA: 50 ppm (269 mg/m^3)
STEL: 200 ppm (1070 mg/m^3)

1990 DFG (Germany) MAK
Ceiling: 50 ppm (270 mg/m^3)
Category II: Substances with systemic effects
Half-life: 2 hr to shift length
Peak Exposure Limit: 250 ppm, 30 min average value; 2 peaks/shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 160 ppm/83 min caused hallucinations and distorted perceptions.
Human, lymphocyte: 5 mL/L caused DNA inhibition.
Rabbit, skin: 500 mg/24 hr caused severe irritation.
Rabbit, eye: 20 mg/24 hr caused moderate irritation.
Mouse, oral, TD_{Lo}: 455 mg/kg administered intermittently for 78 weeks produced liver tumors.

* See NIOSH, *RTECS* (KX4550000), for additional irritation, mutation, reproductive, tumorigenic and toxicity data.

Section 3. Physical Data

Boiling Point: 189 °F (87 °C)
Freezing Point: -121 °F (-85 °C)
Viscosity: 0.0055 Poise at 77 °F (25 °C)
Molecular Weight: 131.38
Density: 1.4649 at 20/4 °C
Refraction Index: 1.477 at 68 °F (20 °C/D)
Odor Threshold: 82 to 108 ppm (*not an effective warning*)
Vapor Pressure: 58 mm Hg at 68 °F (20 °C); 100 mm Hg at 32 °F (0 °C)
Saturated Vapor Density (Air = 0.075 lbs/ft^3; 1.2 kg/m^3): 0.0956 lbs/ft^3; 1.53 kg/m^3
Water Solubility: Very slightly soluble; 0.1% at 77 °F (25 °C)
Other Solubilities: Highly soluble in organic solvents (alcohol, acetone, ether, carbon tetrachloride, & chloroform) and lipids.
Surface Tension: 29.3 dyne/cm

Appearance and Odor: Clear, colorless (sometimes dyed blue), mobile liquid with a sweet chloroform odor.

Section 4. Fire and Explosion Data

Flash Point: 90 °F (32 °C) CC	Autoignition Temperature: 788 °F (420 °C)	LEL: 8% (25 °C); 12.5% (100 °C)	UEL: 10% (25 °C); 90% (100 °C)

Extinguishing Media: A Class 1C Flammable Liquid. Although it has a flash point of 90 °F, TCE burns with difficulty. For small fires, use dry chemical, carbon dioxide, water spray, or regular foam. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Vapor/air mixtures may explode when ignited. Container may explode in heat of fire. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection against TCE. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: TCE slowly decomposes in the presence of light and moisture to form corrosive hydrochloric acid. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include alkalis (sodium hydroxide), chemically active metals (aluminum, beryllium, lithium, magnesium, sodium, potassium, and titanium), epoxides, and oxidants (nitrogen tetraoxide, perchloric acid). Contact with 1-chloro-2,3-epoxy propane or the mono and di 2,3-epoxypropyl ethers of 1,4-butanediol + 2,2-bis-4(2',3'-epoxypropoxy)-phenylpropane can, in the presence of catalytic quantities of halide ions, cause dehydrochlorination of TCE to explosive dichloroacetylene. **Conditions to Avoid:** Exposure to light, moisture, ignition sources, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of TCE (above 300 °C) or exposure to ultraviolet light can produce carbon dioxide (CO_2) and toxic dichloro acetylene (explosive), chlorine, hydrogen chloride, and phosgene gas.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies have rated TCE's carcinogenicity: IARC (Class 3, limited animal evidence & insufficient human data), Germany MAK (Class B, justifiably suspected of having carcinogenic potential), & NIOSH (Class X, carcinogen defined with no further categorization). **Summary of Risks:** TCE vapor is irritating to the eyes, nose, and respiratory tract and inhalation of high concentrations can lead to severe CNS effects such as unconsciousness, ventricular arrythmias, and death due to cardiac arrest. Mild liver dysfunction was also seen at levels high enough to produce CNS effects. Contact with the liquid is irritating to the skin and can lead to dermatitis by defatting the skin. Chronic toxicity is observed in the victims increasing intolerance to alcohol characterized by 'degreasers flush', a transient redness of the face, trunk, and arms. The euphoric effect of TCE has led to craving, and habitual sniffing of its vapors.

Continue on next page

Section 6. Health Hazard Data, *Continued*

TCE crosses the placental barrier and thus exposes the fetus (any effects are yet unknown). There are increased reports of menstrual disorders in women workers and decreased libido in males at exposures high enough to cause CNS effects. TCE is eliminated unchanged in expired air and as [metab]olites (trichloroacetic acid & trichloroethanol) in blood and urine. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of [the n]ervous system, skin, heart, liver, and kidney. **Target Organs:** Respiratory, central & peripheral nervous, and cardiovascular (heart) systems, liver, kidney, and skin. **Primary Entry Routes:** Inhalation, skin and eye contact, and ingestion (rarely). **Acute Effects:** Vapor inhalation can cause eye, nose, and throat irritation, nausea, blurred vision, overexcitement, headache, drunkenness, memory loss, irregular heartbeat (resulting in sudden death), unconsciousness, and death due to cardiac failure. Skin contact with the liquid can cause dryness and cracking and prolonged exposure (generally if the victim is unconscious) can cause blistering. Eye contact can cause irritation and watering, with corneal epithelium injury in some cases. Ingestion of the liquid can cause lip, mouth, and gastrointestinal irritation, irregular heartbeat, nausea and vomiting, diarrhea (possibly blood-stained), drowsiness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Effects may persist for several weeks or months after repeated exposure. Symptoms include giddiness, irritability, headache, digestive disturbances, mental confusion, intolerance to alcohol (degreasers flush), altered color perception, loss or impairment of sense of smell, double vision, and peripheral nervous system function impairment including persistent neuritis, temporary loss of sense of touch, and paralysis of the fingers from direct contact with TCE liquid.

FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Do not give milk, as its fat content (TCE is lipid soluble) may inhance gastrointestinal absorption of TCE. **Note to Physicians:** TCE elimination seems to be triphasic with half lives at 20 min, 3 hr, and 30 hr. Some success is seen in treating patients with propranolol, atropine, and disulfiram. Monitor urine and blood (lethal level = 3 to 110 μg/mL) metabolites. BEI = 100 mg/g creatinine (trichloroacetic acid) in urine, *sample at end of workweek.* BEI = 4 mg/L (trichloroethanol) in blood, *sample at end of shift at end of the workweek.* These tests are not 100% accurate indicators of exposure; monitor TCE in expired air as a confirmatory test.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container for later disposal. For large spills, flush to containment area where density stratification will form a bottom TCE layer which can be pumped and containerized. Report any release in excess of 1000 lbs. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Bluegill sunfish, LC_{50} = 44,700 μg/L/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 40.7 mg/L/96 hr. **Environmental Degradation:** In air, TCE is photooxidized with a half-life of 5 days and reported to form phosgene, dichloroacetyl chloride, and formyl chloride. In water it evaporates rapidly in minutes to hours. TCE rapidly evaporates and may leach since it does not absorb to sediment. **Soil Absorption/Mobility:** TCE has a Log K_{oc} of 2, indicating high soil mobility. **Disposal:** Waste TCE can be poured on dry sand and allowed to vaporize in isolated location, purified by distillation, or returned to supplier. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) with an acid scrubber to remove halo acids. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

[EPA] Designations

[Listed as a SAR]A Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33 & 261.31): No. U228 & F002 (*spent solvent*)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001, CWA Sec. 311 (b)(4), & CWA Sec. 307 (a)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear chemical safety goggles (cup-type or rubber framed, equipped with impact-resistant glass), per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. At any detectable concentration, wear a SCBA with a full facepiece operated in pressure demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made from Viton or Neoprene to prevent skin contact. *Do not* use natural rubber or polyvinyl chloride (PVC). **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in steel drums, in a cool, dry, well-ventilated area away from sunlight, heat, ignition sources, and incompatibles (Sec. 5). Store large quantities in galvanized iron, black iron, or steel containers; small amounts in dark (amber) colored glass bottles. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Design processes so that the operator is not directly exposed to the solvent or its vapor. Do not use open electric heaters, high-temperature processes, arc-welding or open flames in TCE atmospheres. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on skin, respiratory, cardiac, central and peripheral nervous systems, and liver and kidney function. Employ air and biological monitoring (BEIs). Instruct employees on safe handling of TCE.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Trichloroethylene
Hazard Class: 6.1
[ID N]o.: UN1710
DOT Packing Group: III
DOT Label: Keep Away From Food
DOT Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60L
b) Cargo Aircraft Only: 220L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** AC Darlington, MD

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Material Safety Data Sheets Collection:

Sheet No. 311
Methyl Chloroform

Issued: 11/75 Revision: F, 3/92 Errata: 6/92

Section 1. Material Identification — 38

Methyl Chloroform ($C_2H_3Cl_3$) Description: Derived by catalytic addition of hydrogen chloride to 1,1-dichloroethylene or by re-fluxing chlorine monoxide with carbon tetrachloride and chloroethane. Available in technical and solvent grades which differ only in the amount of stabilizer added to prevent metal parts corrosion. Used as a solvent for oils, waxes, tars, cleaning precision instruments, and pesticides; as a component of inks and drain cleaners; in degreasing metals, and textile processing. In recent years, methyl chloroform has found widespread use as a substitute for carbon tetrachloride.

R 1, I 2, S 2*, K 1

Genium: 1, 2, 1, —

Other Designations: CAS No. 71-55-6, α-trichloroethane; Inhibisol; 1,1,1-trichloroethane; Strobane.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Methyl chloroform is a skin, eye, and respiratory tract irritant and can become narcotic with an anesthetic effect at high concentrations.

HMIS: H 2, F 1, R 1, PPG*

* Data on skin absorption via methyl chloroform is conflicting.[133] Some studies show definite absorption where others don't.

* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Methyl chloroform, ca 92 to 97%*

1990 OSHA PELs
8-hr TWA: 350 ppm (1900 mg/m^3)
15-min STEL: 450 ppm (2450 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH REL
15-min Ceiling: 350 ppm (1900 mg/m^3)

1991-92 ACGIH TLVs
TWA: 350 ppm (1910 mg/m^3)
STEL: 450 ppm (2460 mg/m^3)

1990 DFG (Germany) MAKs
TWA: 200 ppm (1080 mg/m^3)
Half-life: 2 hr to shift length
Peak Exposure Limit: 1000 ppm/30 min (average value)/2 per shift

1985-86 Toxicity Data†
Human, oral, TD_{Lo}: 670 mg/kg produced diarrhea, nausea, and vomiting
Human, inhalation, LC_{Lo}: 27 g/m^3/10 min; toxic effects not yet reviewed
Man, eye: 450 ppm/8 hr produced irritation
Rat, inhalation, TC_{Lo}: 2100 ppm/24 hr for 14 days prior to mating and from 1 to 20 days of pregnancy produced specific developmental abnormalities of the musculoskelatal system

* Methyl chloroform usually contains inhibitors (3 to 8%) to prevent corrosion of aluminum and some other metals. Typical inhibitors are nitromethane, butylene oxide, secondary butyl alcohols, ketones, and glycol diesters.
† See NIOSH, *RTECS* (KJ2975000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 165 °F (75 °C)
Freezing Point: -22 °F (-30 °C)
Vapor Pressure: 100 mm Hg at 68 °F (20 °C)
Vapor Density (air = 1): 4.55
Corrosivity: Readily corrodes aluminum and its alloys
Refraction Index: 1.43765 at 69.8 °F (21 °C)
Viscosity: 0.858 cP at 68 °F (20 °C)
Molecular Weight: 133.42
Density: 1.3376 at 68/39.8 °F (20/4 °C)
Water Solubility: Insoluble
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, carbon tetrachloride, and carbon disulfide
% in Saturated Air: 16.7% at 77 °F (25 °C)
Relative Evaporation Rate (butyl acetate = 1): 12.8

Appearance and Odor: Colorless liquid with a sweetish, chloroform-like odor. The odor threshold is 44 ppm.

Section 4. Fire and Explosion Data

Flash Point: None (in conventional CC tests)	Autoignition Temperature: 932 °F (500 °C)	LEL: 7% v/v	UEL: 16% v/v

Extinguishing Media: *Noncombustible liquid* whose *vapor* burns in the presence of excess oxygen or a strong ignition source. For small fires, use dry chemical or carbon dioxide (CO_2). For large fires use fog or regular foam. If these materials are unavailable, a water spray may be used but be aware that water reacts slowly with methyl chloroform to release hydrochloric acid.
Unusual Fire or Explosion Hazards: Vapors are heavier than air and may travel to a strong ignition source and flash back. Air/vapor mixtures may explode when heated. Container may explode in heat of fire. Exposure to open flames or arc welding can produce hydrogen chloride and phosgene.
Special Fire-fighting Procedures: Methyl chloroform's burning rate is 2.9 mm/min. Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides limited protection. Wear clothing specifically recommended by the manufacturer for use in fires involving methyl chloroform. Apply cooling water to container sides until after fire is extinguished. Stay away from ends of tanks. Isolate area for 1/2 mile if fire involves tank, truck, or rail car. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Methyl chloroform is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can occur in contact with aluminum trichloride.
Chemical Incompatibilities: Methyl chloroform is incompatible with sodium hydroxide, nitrogen tetroxide, oxygen (liquid or gas), strong oxidizers, and chemically active metals like aluminum, zinc, and magnesium powders; reacts violently with caustics to form dichloroacetylene; reacts slowly with water to form hydrochloric acid; forms shock sensitive mixtures with potassium; and polymerizes in contact with aluminum trichloride.
Conditions to Avoid: Exposure to moisture, strong ignition sources, and arc-welding units, and contact with incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition (temperatures >500 °F, contact with hot metals, or under UV rays) of methyl chloroform can produce carbon dioxide (CO_2) and toxic dichloroacetylene, hydrogen chloride, and phosgene gases.

Section 6. Health Hazard Data

Carcinogenicity: The IARC (Class 3, inadequate evidence),[164] NTP,[142] and OSHA[164] do not list methyl chloroform as a carcinogen.
Summary of Risks: Methyl chloroform is considered one of the least toxic of the liquid chlorinated hydrocarbons. It is irritating to eyes, skin, and respiratory tract. Although low in systemic toxicity, methyl chloroform is an anesthetic capable of causing death at high concentrations (>15,000 ppm), generally in poorly ventilated, enclosed areas. Quick and complete recovery is observed after prompt removal of unconscious persons from area of exposure. Like many other solvents, methyl chloroform sensitizes the heart to epinephrine (blood pressure-raising hormone) and may induce cardiac arrhythmias and arrest.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eyes, central nervous (CNS) and cardiovascular (CVS) systems.

Continue on next page

Section 6. Health Hazard Data, *continued*

Primary Entry Routes: Inhalation, skin contact. **Acute Effects:** Methyl chloroform defats the skin causing irritation, redness, dryness, and scaling. Contact with eyes produces irritation and mild conjunctivitis. Vapor inhalation can cause headache, dizziness, equilibrium disturbances, and in high concentrations may lead to CNS depression, unconsciousness, and coma. During a 60-min exposure period these effects are observed: 100 ppm is the observed odor threshold, at 500 ppm there is obvious odor and decreased reaction time, 1000 ppm causes slight equilibrium loss, at 5000 ppm there is definite incoordination, and 20,000 ppm produces surgical strength anesthesia with possible death. Mild liver and kidney dysfunction may occur after CNS depression recovery. Although unlikely, if ingestion occurs, symptoms include nausea, vomiting, diarrhea, and possible esophageal burns. The acute lethal human dose is ~500 to 5000 mg/kg. **Chronic Effects:** None reported.

FIRST AID

Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* allow victim to rub or keep eyes tightly shut. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.
Inhalation: Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center, and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. When deciding whether to induce vomiting, carefully consider amount ingested, time since ingestion, and availability of medical help. If large amounts are recently ingested (absorption into the body is not yet likely to have occurred), and medical help or transportation to a medical facility is not readily available, induce vomiting. Otherwise, vomiting is not recommended since aspiration of vomitus can produce chemical pneumonitis.
Note to Physicians: Do not use adrenaline or sympathomimetic amines in treatment because of the increased cardiac sensitivity involved.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources. If possible without risk, shut off leak. Cleanup personnel should wear fully encapsulating vapor-protective clothing. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material. Using nonsparking tools, place in suitable containers for disposal or reclamation. For large spills, dike far ahead of liquid spill for later disposal or reclamation. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Transport: In water, methyl chloroform's half-life is hours to weeks depending on wind and mixing conditions. It is very persistent in groundwater. On land it volatilizes due to its high vapor pressure and leaches extensively. When released to the atmosphere, methyl chloroform can be transported long distances and returned to earth via rain. It is slowly degraded by reaction with hydroxyl radicals and has a half-life of 6 months to 25 years. The Natural Resources Defenses Council reported recently that methyl chloroform depletes ozone.
Ecotoxicity Values: *Pimephales promelas* (fathead minnow), LC_{50}: 52.8 mg/L/96 hr; *Poecilia reticulata* (guppy), LC_{50}: 133 ppm/7 day.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U226
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 1000 lb (454 kg) [* per RCRA, Sec. 3001, CWA, Sec. 307(a), and CAA, Sec. 112]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear splash-proof, protective chemical safety goggles or faceshields, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Other: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent repeated or prolonged skin contact. Viton and butyl rubber [with breakthrough times (BTs) of >8 hr and 4 to 7.9 hr, respectively] are recommended materials for protective gear. *Do not use* neoprene, polyvinyl chloride (PVC), natural rubber, or polyethylene because these materials have a BT of <1 hr.
Ventilation: Provide general and local exhaust (in some cases, explosion-proof) ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in cool, dry, well-ventilated (use pressure-vacuum ventilation) area away from ignition sources, arc-welding operations, and incompatibles (Sec. 5). Regularly monitor inhibitor levels. *Do not* store in aluminum containers or use pressure-spraying equipment when methyl chloroform is involved.
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. To prevent static sparks, electrically ground and bond all equipment used in methyl chloroform manufacturing, use, storage, transfer, and shipping.
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers that emphasize CNS, CVS, liver and skin.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: 1,1,1-Trichloroethane
DOT Hazard Class: ORM-A
ID No.: UN2831
DOT Label: None
DOT Packaging Exceptions: 173.505
DOT Packaging Requirements: 173.605

IMO Shipping Name: 1,1,1-Trichloroethane
IMO Hazard Class: 6.1
ID No.: UN2831
IMO Label: St. Andrews Cross
IMDG Packaging Group: III

MSDS Collection **References:** 26, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 148, 153, 159, 162, 163, 164

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** AC Darlington, MPH, MD; **Edited by:** JR Stuart, MS 64

Section 1. Material Identification 39

Vinyl Chloride (C_2H_3Cl) Description: Derived from ethylene dichloride and alcoholic potassium, by reaction of acetylene and hydrogen chloride (as gas or liquids), or by oxychlorination where ethylene reacts with hydrochloric acid and oxygen. Inhibitors such as butyl catechol, hydroquinone, or phenol are added to prevent polymerization. Used in the plastics industry for the production of polyvinyl chloride resins, in organic synthesis and formerly as a refrigerant, extraction solvent, and propellant (banned in 1974 because of its carcinogenic activity).

Other Designations: CAS No. 75-01-4, chloroethylene, chloroethene, ethylene monochloride, Trovidur, VC, VCM.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Vinyl chloride is a confirmed human carcinogen. Vapor inhalation leads to central nervous system (CNS) depression. The liquid can cause frostbite. It is a flammable gas at room temperature and polymerizes on exposure to air or sunlight. Avoid exposure to VC through engineering controls and wearing PPE

R 2
I 4
S 4
K 4

NFPA
4
2 2
-

HMIS
H 3*
F 4
R 2
PPE - Sec. 8
* Chronic effects

Section 2. Ingredients and Occupational Exposure Limits

Vinyl Chloride, ca 98 to 99%. Impurities include water, acetaldehyde, hydrogen chloride, hydrogen peroxide, methyl chloride, butane, 1,3-butadiene, chlorophene, diacetylene, vinyl acetylene, and propine.

1991 OSHA PELs
8-hr TWA: 1 ppm
Ceiling: 5 ppm; OSHA-X

1990 NIOSH REL
NIOSH-X

1992-93 ACGIH TLV
TWA: 5 ppm (13 mg/m^3)
TLV-A1

1990 DFG (Germany) TRK*
Existing Installations: 3 ppm
MAK-A1

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: Intermittent exposure to 200 ppm for 14 yr caused liver tumors.
Man, inhalation, TC_{Lo}: 30 mg/m^3/5 yr caused spermatogenesis.
Human, inhalation, TC: Continuous exposure to 300 mg/m^3 for an undetermined number of weeks caused blood tumors.
Rat, oral, LD_{50}: 500 mg/kg; toxic effects not yet reviewed

* TRK (technical exposure limit) is used in place of MAK when a material is a carcinogen. Unlike an MAK below which no adverse effects are expected, the TRK is a limit set below which adverse effects may still occur. This is based on the theory that 1 molecule of a carcinogenic substance may still produce a tumor. The TRK is set to allow for an acceptable risk (for example, 1 tumor in 1 million persons may be an acceptable risk).
† See NIOSH, *RTECS* (KU9625000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 7 °F (-13.9 °C)
Freezing Point: -245 °F (-159.7 °C)
Molecular Weight: 62.5
Specific Gravity: 0.9106 at 68 °F (20 °C)
Ionization Potential: 9.99 eV
Refraction Index: 1.370 at 20 °C/D
Surface Tension: 23.1 dyne/cm at -4 °F (-20 °C)
Odor Threshold: 2000 to 5000 ppm*
Vapor Density (Air = 1): 2.155
Water Solubility: Slightly soluble, 0.1% at 77 °F (25 °C)
Other Solubilities: alcohol, benzene, carbon tetrachloride, ether, hydrocarbon and oils.
Vapor Pressure: 2530 mm Hg at 68 °F (20 °C), 400 mm Hg at -18.4 °F (-28 °C)
Critical Temperature: 304.7 °F (151.5 °C)
Critical Pressure: 56.8 atm
Viscosity: 0.01072 cP at 68 °F (20 °C), *gas*; 0.28 cP at -4 °F (-20 °C), *liquid*
Appearance and Odor: A gas at room temperature. Usually found as a compressed/cooled liquid. The colorless liquid forms a vapor with a pleasant ethereal odor.

*The actual vapor concentration that can be detected by humans has not been adequately determined and varies from one individual to another, from impurities, and probably from exposure duration. The odor threshold is not an accurate warning of exposure.

Section 4. Fire and Explosion Data

Flash Point: -108.4 °F (-78 °C) OC	Autoignition Temperature: 882 °F (472 °C)	LEL: 3.6% v/v	UEL: 33% v/v

Extinguishing Media: For small fires, use dry chemical or carbon dioxide. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Large fires can be practically inextinguishable. Vapors may travel to an ignition source and flash back. VC may polymerize in cylinders or tank cars and explode in heat of fire. Vapors pose an explosion hazard indoors, outdoors, and in sewers. VC decomposes in fire to hydrogen chloride, carbon monoxide, carbon dioxide, and phosgene. Burning rate = 4.3 mm/min. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Stop gas leak if possible. Let tank, tank car, or tank truck burn unless leak can be stopped. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if this is impossible, withdraw from area and let fire burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. *Do not* release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Long term exposure to air may result in formation of peroxides which initiates explosive polymerization of the chloride. VC can polymerize on exposure to light or in presence of a catalyst. **Chemical Incompatibilities:** VC can explode on contact with oxide of nitrogen, may liberate hydrogen chloride on exposure to strong alkalies, and is incompatible with copper, oxidizers, aluminum, and peroxides. In the presence of moisture, VC attacks iron and steel. **Conditions to Avoid:** Exposure to sunlight, air, heat, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of vinyl chloride can produce carbon oxides, and chloride gas.

Section 6. Health Hazard Data

Carcinogenicity: Vinyl chloride is listed as a carcinogen by the IARC (Class 1, *sufficient human evidence*),[164] NTP (Class 1, *sufficient human evidence*),[169] NIOSH (Class X, *carcinogen defined without further categorization*),[163] ACGIH (TLV-A1, *confirmed human carcinogen*),[163] DFG (MAK-A1, *capable of inducing malignant tumors in humans*),[163] and OSHA (Class X, *carcinogen defined without further categorization*).[164] Liver tumors (angiosarcomas) are confirmed from VC exposure. Other tumors of the CNS, respiratory system, blood, and lymphatic system have occurred from exposure to the polyvinyl chloride manufacture process but VC itself may not be the causative agent. **Summary of Risks:** Vapor inhalation causes varying degrees of CNS depression with noticeable anesthetic effects at levels of 1% (10,000 ppm). Studies have shown loss of libido and sperm in men exposed to VC and in Russian studies, 77% of exposed women experienced ovarian dysfunction, benign uterine growths, and prolapsed genital organs. However, no teratogenic effects have been seen in offspring of exposed workers.

Continue on next page

Section 6. Health Hazard Data, *continued*

It appears that metabolism is necessary before many of VC's toxic effects occur. Some vinyl chloride is exhaled unchanged but most is metabolized to chloroacetaldehyde. Skin absorption may occur if liquid is confined on skin but absorbed amount would be small. It is possible that the phenol inhibitor may be absorbed as well. The compressed liquid can cause frostbite. Vapors are severely irritating to the eyes. Chronic exposure can cause cancer and a ad of syndromes known as *vinyl chloride disease*. **Medical Conditions Aggravated by Long-Term Exposure:** Liver, cardiac, pulmonary, and connective tissue disorders. **Target Organs:** Liver, CNS, respiratory and lymphatic systems, bone, and connective tissue of the skin. **Primary Entry Routes:** Inhalation, skin/eye contact. **Acute Effects:** CNS effects include fatigue, headache, vertigo, ataxia, euphoria, visual disturbances, dulling of auditory cues, numbness and tingling in the extremities, narcosis, unconsciousness, and death due to respiratory failure. Respiratory problems include dyspnea, asthma, and pneumonoconiosis. **Chronic Effects:** Repeated exposure has lead to liver cancer; confirmed because of the otherwise rarity of its type (angiosarcoma). Tumors in other organs have occurred in the polyvinyl chloride industry but agents other than VC may be responsible; authorities are still debating this issue. A triad of other effects are associated with VC exposure. Acro-osteolysis is associated with hand cleaning of polymerization vessels and characterized by dissolution of bone in the hands, especially when associated with resorption. Raynaud's Phenomenon is a vascular disorder marked by recurrent spasm of the capillaries and especially those of the fingers and toes on exposure to cold. This is usually accompanied by pain and in severe cases may progress to local gangrene. Sclerodermatous skin changes (affecting the dorsal hands and distal forearms) are seen and described as a slowly progressive disease marked by deposition of fibrous connective tissue in the skin. The skin becomes thickened and raised nodules appear. Arthralgias (pain in one or more joints) and blood changes with decreased platelet number and capillary abnormalities may also occur.

FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. For frostbite, immerse affected area in 107.6 °F (42 °C) water until completely rewarmed. *Do not* use dry heat. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Unlikely! VC is a gas above 7 °F (-14°C). **Note to Physicians:** *Endotracheal intubation may be required if significant CNS or respiratory depression occur.* Diagnostic test: thiodiglycolic acid in urine (normally < 2 mg/g creatinine).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. If possible without risk, stop gas flow. Shut off ignition sources. Report any release > 1 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** VC reacts with hydroxyl radicals in the trophosphere with a half-life of 1.2 days. The half-life = a few hr in photochemical smog. Reaction products in the air include chloroacetaldehyde, hydrogen chloride, chloroethylene, epoxide, formaldehyde, formyl chloride, formic acid, and carbon monoxide. In soil, VC rapidly volatilizes. *What does not evaporate will be highly mobile and may leach into groundwater.* In water, VC is not expected to hydrolyze, bioconcentrate, or absorb to sediment. It will rapidly volatilize with an estimated half-life of 0.805 hr for evaporation from a river 1 meter deep with a current of 3 meter/sec and a wind velocity of 3 meter/sec. In waters containing photosensitizers such as humic acid, photodegradation will be rapid. **Soil Absorption/Mobility:** From an estimated solubility of 2,700 ppm, a Koc of 56 is established for VC which indicates high soil mobility and potential to leach into groundwater. **Disposal:** Dilute any waste compressed liquid to a 1% solution and remove phenol inhibitor as sodium. Pour onto vermiculite, sodium bicarbonate, or a sand & soda ash mixture (90/10). Add slaked lime if fluoride is present. Mix in paper boxes, place in incinerator, cover with scrap wood and paper, and ignite with excelsior train. Another method is to dissolve waste in a flammable solvent and spray in incinerator firebox equipped with an afterburner and alkali scrubber. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U043

SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1 lb (0.454 kg) [* per CWA, Sec. 307 (a); CAA, Sec. 112, & RCRA, Sec. 3001]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. According to NIOSH[148], for any detectable concentration use a SCBA or supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode. See 29 CFR 1910.1017 for detailed OSHA respirator recommendations. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of Viton or chlorinated polyethylene to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL's (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate work clothes from street clothes, launder before reuse and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a cool, dry, well-ventilated area in clearly labeled containers. Outside or detached storage is preferred. Large amounts should be stored in steel containers under pressure. Keep separate from incompatibles (Sec. 5). Venting, under pressure should be safety relief. At atm, venting should be pressure vacuum. Regularly monitor inhibitor levels. To avoid static sparks, electrically ground and bond all equipment used with VC. Avoid open flames, spark formation and electric discharges around VC. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Install Class 1, Group D electrical equipment. **Administrative Controls:** Inform VC exposed personnel of hazards associated with its use. Preplacement and periodic medical exams of workers exposed above the action level is mandatory under OSHA 29 CFR (1910.1017). Monitor for liver cancer, scleroderma, pneumonitis, clotting abnormalities, and acro-osteolysis.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Vinyl Chloride
DOT Hazard Class: 2.1
ID No.: UN1086
DOT Packing Group: --
DOT Label: Flammable Gas
Special Provisions (172.102): B44

Packaging Authorizations
a) Exceptions: 173.306
b) Non-bulk Packaging: 173.304
c) Bulk Packaging: 173.314 & 173.315

Quantity Limitations
a) Passenger Aircraft or Railcar: Forbidden
b) Cargo Aircraft Only: 150 kg

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: 40

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168, 171, 174, 175

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** AC Darlington, MPH, MD

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Material Safety Data Sheets Collection:

Sheet No. 316
Benzene

Issued: 11/78 Revision: E, 8/90

Section 1. Material Identification

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Benzene (C_6H_6) Description: Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.

Other Designations: CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[(73)] for a suppliers list.

R 1
I 4
S 2*
K 4
*Skin absorption

NFPA: Health 2, Flammability 3, Reactivity 0

HMIS
H 3
F 3
R 0
PPG†
† Sec. 8

Cautions: Benzene is a confirmed *human carcinogen* by the IARC. *Chronic low-level exposure may cause cancer (leukemia) and bone marrow damage, with injury to blood-forming tissue.* It is also a dangerous fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

1989 OSHA PELs
(29 CFR 1910.1000, Table Z-1-A)
8-hr TWA: 1 ppm, 3 mg/m³
15-min STEL: 5 ppm, 15 mg/m³

(29 CFR 1910.1000, Table Z-2)
8-hr TWA: 10 ppm
Acceptable Ceiling Concentration: 25 ppm
Acceptable Maximum Peak: 50 ppm (10 min)†

1989-90 ACGIH
TLV-TWA: 10 ppm, 32 mg/m³

1988 NIOSH RELs
TWA: 0.1 ppm, 0.3 mg/m³
Ceiling: 1 ppm, 3 mg/m³

1985-86 Toxicity Data‡
Man, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted
Man, inhalation, TC_{Lo}: 150 ppm inhaled intermittently over 1 yr in a number of discrete, separate doses affects the blood (other changes) and nutritional and gross metabolism (body temperature increase)
Rabbit, eye: 2 mg administered over 24 hr produces severe irritation

* OSHA 29 CFR 1910.1000, Subpart Z, states that the final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limits in Table Z-2 apply.
† Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift.
‡ See NIOSH, *RTECS* (CY1400000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 176 °F (80 °C)
Melting Point: 42 °F (5.5 °C)
Vapor Pressure: 100 mm Hg at 79 °F (26.1 °C)
Vapor Density (Air = 1): 2.7
Evaporation Rate (Ether = 1): 2.8
Molecular Weight: 78.11
Specific Gravity (15 °C/4 °C): 0.8787
Water Solubility: Slightly (0.180 g/100 g of H_2O at 25 °C)
% Volatile by Volume: 100
Viscosity: 0.6468 mPa at 20 °C

Appearance and Odor: A colorless liquid with a characteristic sweet, aromatic odor. The odor recognition threshold (100% of panel) is approximately 5 ppm (unfatigued) in air. Odor *is not* an adequate warning of hazard.

Section 4. Fire and Explosion Data

Flash Point: 12 °F (-11.1 °C), CC	Autoignition Temperature: 928 °F (498 °C)	LEL: 1.3% v/v	UEL: 7.1% v/v

Extinguishing Media: Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can scatter and spread the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an unignited benzene leak.

Unusual Fire or Explosion Hazards: Benzene is a Class IB flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Structural firefighter's protective clothing provides limited protection. Stay out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Runoff to sewer can create pollution, fire, and explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Benzene explodes on contact with diborane, permanganic acid, bromine pentafluoride, peroxodisulfuric acid, and peroxomonosulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxide + water. Benzene forms sensitive, explosive mixture with iodine pentafluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentafluoride + potassium methoxide (explodes above 30 °C). A vigorous or incandescent reaction occurs with bromine trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.

Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, OSHA, and IARC list benzene as, respectively, a supected human carcinogen, a cancer hazard, and, based on sufficient human and animal evidence, a human carcinogen (Group 1).
Summary of Risks: Prolonged skin contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher level exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.
Medical Conditions Aggravated by Long-Term Exposure: Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.
Target Organs: Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.
Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).
Chronic Effects: Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Immediately rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* since aspiration may be fatal. Call a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure. Acute management is primarily supportive for CNS depression.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a benzene spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. *Absorb as much benzene as possible with an inert, noncombustible material. For large spills, dike far ahead of spill* and contain liquid. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of confined spaces such as sewers, watersheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), 311 (b)(4), 112; and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations at least below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials. *Caution! Benzene vapor may form explosive mixtures in air.* To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. When opening or closing benzene containers, use nonsparking tools. Keep fire extinguishers readily available.
Engineering Controls: Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD."
Other Precautions: Provide preplacement and periodic medical examinations with emphasis on a history of blood disease or previous exposure.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Benzene (*benzol*)
DOT Hazard Class: Flammable liquid
ID No.: UN1114
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Benzene
IMO Hazard Class: 3.2
ID No.: UN1114
IMO Label: Flammable liquid
IMDG Packaging Group: II

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE–NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

MSDS Collection References: 1, 2, 12, 26, 73, 84-94, 100, 101, 103, 109, 124, 126, 127, 132, 134, 136, 138, 139, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 538
Ethyl Chloride
Issued: 5/85 Revision: A, 5/93

Section 1. Material Identification 41

Ethyl Chloride (CH_3CH_2Cl) Description: Derived by passing hydrogen chloride into a solution of zinc chloride and ethanol or by action of chlorine on ethylene in presence of chlorides of copper, iron, antimony, and calcium. Used in organic synthesis, refrigeration, manufacture of insecticides, ethyl cellulose, dyes, drugs, and perfumes; as an alkylating agent and analytical agent; solvent for fats, oils, waxes, phosphorus, acetylene, and many resins; propellant in aerosols; and formerly as an anesthetic (no longer used because of possible respiratory and circulatory depression).

Other Designations: CAS No. 75-00-3, Aethylis, Anodynon, Chloridium, chloroethane, chloryl anesthetic, hydrochloric ether, Kelene, monochloroethane, muriatic ether, Narcotile.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Ethyl Chloride is a highly flammable and explosive gas. Inhalation of high concentrations can cause central nervous system depression. Skin absorption is possible and the liquid can cause frostbite.

R 1
I 2
S 2*
K 4
* Skin absorption

NFPA
4
2 0
–

HMIS
H 2
F 4
R 1
PPE†
† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Ethyl Chloride, ca 100%

1992 OSHA PELs
Transitional & Final Rule Limits
8-hr TWA: 1000 ppm (2600 mg/m^3)

1993-94 ACGIH TLV*
TWA: 1000 ppm (2640 mg/m^3)

1992 Toxicity Data†
Rat, inhalation, LC_{50}: 160 g/m^3/2 hr; no toxic effects noted

1990 IDLH Level
20,000 ppm

1991 DFG (Germany) MAK
None established

1992 NIOSH REL
None established

* Notice of intended change to 100 ppm (264mg/m^3) and designation as a class A3 carcinogen (animal carcinogen).
†See NIOSH, *RTECS* (KH7525000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: 54 °F (12 °C)
Freezing Point: -217.6 °F (-138.7 °C)
Vapor Pressure: 1064 mm Hg at 68 °F (20 °C)
Density (Air = 1): 2.22
Surface Tension: 19.5 dyne/cm at 68 °F (20 °C)
Ionization Potential: 10.97 eV
Relative Evaporation Rate (BuAc =1): > 1
Viscosity: 0.279 cP at 50 °F (10 °C)
Octanol/Water Partition Coefficient: log Kow = 1.43
Molecular Weight: 64.52
Specific Gravity: 0.9214 at 32 °F (0 °C)
Water Solubility: 0.57% at 68 °F (20 °C)
Other Solubilities: Per 100 g water at 77 °F (25 °C): acetone (103 g), benzene (110 g), *n*-heptane (87 g), methanol (37 g); at (21 °C): ethanol (48 g)
Odor Threshold: 4.2 ppm (should be sufficient warning)
Critical Pressure: 52 atm
Critical Temperature: 368.9 °F (187.2 °C)

Appearance and Odor: Colorless gas with an ethereal, slightly pungent odor at room temperature. When compressed, it is a colorless, volatile liquid.

Section 4. Fire and Explosion Data

Flash Point: -58 °F (-50 °C) CC	**Autoignition Temperature:** 966 °F (519 °C)	**LEL:** 3.8% v/v	**UEL:** 15.4% v/v

Extinguishing Media: For small fires, use dry chemical, water spray, or regular foam. For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: Burning rate = 3.8 mm/minute. Container may explode in heat of fire. Ethyl chloride presents a vapor explosion hazard indoors, outdoors, and in sewers. Burns with a smoky, greenish flame.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection. Apply cooling water to sides of containers until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Withdraw immediately in case you hear a rising sound from venting safety device or notice any tank discoloration due to fire. *Do not* release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

Stability/Polymerization: Ethyl chloride is stable up to 752 °F (400 °C) in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Include oxidizing materials, water/steam (produces hydrogen chloride), sodium, potassium, calcium, and powdered aluminum, copper, magnesium, and zinc.
Conditions to Avoid: Contact with heat, ignition sources, and incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of ethyl chloride can produce phosgene, and hydrogen chloride gas.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies consider ethyl chloride to be a carcinogen: NIOSH-X[183] and DFG MAK-B.[183] The NTP has positive studies (equivocal tumorigenic agent) but no carcinogen designations have been assigned.
Summary of Risks: Ethyl chloride does not appear to present a serious industrial health hazard because very high concentrations are needed to produce adverse effects. If concentrations are high, central nervous system depression is the most common effect and... *Continue on next page*

Section 6. Health Hazard Data, *continued*

the resulting "drunkenness" and incoordination may lead to incorrect machinery operation with possible injury. Ethyl chloride can be absorbed through the skin and frostbite is possible from contact with the liquid (compressed gas).

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Respiratory and cardiovascular system; liver and kidneys (seen in animals and is possible but not likely in humans).

Primary Entry Routes: Inhalation, skin absorption.

Acute Effects: At high concentrations, inhalation can cause central nervous system depression and cardiac arrythmias. Some irritation of the eyes, skin, and respiratory tract is also possible. Allergic eczema is reported in two individuals subjected to an allergy test but it is not expected to occur frequently. Volunteers exposed to 40,000 ppm experienced dizziness, eye irritation, and abdominal cramps; 25,000 ppm caused incoordination; 19,000 produced analgesia after 12 minutes; and 13,000 ppm resulted in slight inebriation. Ethyl chloride is quickly absorbed both via the lungs and through the skin but most is eliminated via the lungs just as quickly.

Chronic Effects: None reported.

FIRST AID **Eyes and Skin:** The liquid (compressed gas) can cause frostbite. Immerse affected skin (or rinse eyes) with tepid water (104 °F/ 40 °C) until completely rewarmed. *Do not* rub affected area or use dry heat!

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treatment is symptomatic and supportive.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Isolate and ventilate area, deny entry, and stay upwind. Stop gas flow. Shut off all ignition sources. Cleanup personnel should protect against gas inhalation and contact with the liquid. It is a gas above 54 °F (12 °C) so if spilled as a liquid, it would tend to evaporate before cleanup could begin. Prevent entry into sewers, drains, and waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Degradation: In water, some ethyl chloride will volatilize with estimated half-life of 1.1 to 5.6 days and some will hydrolyze with an estimated half-life of 38 days at 77 °F (25 °C). In soil, some will volatilize (dry soil) or leach; and some will hydrolyze (moist soil). In air, ethyl chloride will react with photochemically produced hydroxyl radicals with an estimated half-life of 40 days.

Soil Absorption/Mobility: With estimated Koc values of 33 and 143, ethyl chloride is expected to be highly mobile.

Disposal: Thermal destruction is difficult unless a gas feed to an incinerator (permit-approved facility only) can be arranged. Complete combustion is necessary to prevent the formation of phosgene gas. Incinerator should be equipped with an afterburner and scrubber to remove the halo-acids. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a SARA Toxic Chemical (40 CFR 372.65)

SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed

Listed as a RCRA Hazardous Waste (40 CFR 261.21): D001, "Characteristic of Ignitability"

Listed "chlorinated ethanes" as a CERCLA Hazardous Substance* (40 CFR 302.4); per CWA, Sec. 307 (a)

* An RQ is not given for the broad class.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because *contact lens use in industry is controversial, establish your own policy.*

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 10,000 ppm, use a supplied-air respirator (SAR) or SCBA. For < 20,000 ppm, use a SAR operated in continuous-flow mode or any SAR or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other: Wear chemically protective gloves, boots, aprons, and gauntlets made of Viton, nitrile, or butyl rubber to prevent skin contact.

Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Separate work and street clothes and launder before reuse. Remove ethyl chloride from shoes and clean PPE.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using ethyl chloride, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage/Handling Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles. Outside or detached storage is preferred. Inside storage should be in a standard flammable liquids storage cabinet.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Install Class I, Group D electrical equipment

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers. Educate workers on ethyl chloride's explosive potential.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Ethyl Chloride
DOT Hazard Class: 2.1
ID No.: UN1037
DOT Packing Group: —
DOT Label: Flammable Gas
Special Provisions (172.102): B63, B77

Packaging Authorizations
a) Exceptions: None
b) Non-bulk Packaging: 173.322
c) Bulk Packaging: 173.314, .315

Quantity Limitations
a) Passenger Aircraft or Railcar: Forbidden
b) Cargo Aircraft Only: 150 kg

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 153, 159, 164, 167, 168, 176, 183, 186

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Material Safety Data Sheets Collection:

Sheet No. 385
Ethylbenzene

Issued: 8/78 Revision: B, 9/92

Section 1. Material Identification

Ethylbenzene ($C_6H_5C_2H_5$) Description: Derived by heating benzene and ethylene in presence of aluminum chloride with subsequent distillation, by fractionation directly from the mixed xylene stream in petroleum refining, or dehydrogenation of naphthenes. Used as a solvent, an antiknock agent in gasoline; and as an intermediate in production of synthetic rubber, styrene, cellulose acetate, diethylbenzene, acetophenone, ethyl anthraquinone, propyl oxide, and α-methylbenzol alcohol.
Other Designations: CAS No. 100-41-4, ethylbenzol, EB, phenylethane, NCI-C56393.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 3
S 2*
K 4
* Skin absorption

NFPA: 3 (health 2, flammability 3, reactivity 0)

HMIS
H 2†
F 3
R 0
PPE - Sec.
† Chronic effects

Cautions: Ethylbenzene is a skin and mucous membrane irritant considered the most irritating of the benzene series. Inhalation causes acute and chronic central nervous system (CNS) effects. It is highly flammable and forms explosive mixtures with air.

Section 2. Ingredients and Occupational Exposure Limits

Ethylbenzene, ca >99.0%. Impurities include ~ 0.1% *meta* & *para* xylene, ~ 0.1% cumene, and ~ 0.1% toluene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m³)
15-min STEL: 125 ppm (545 mg/m³)
Action Level: 50 ppm (217 mg/m³)

1990 IDLH Level
2000 ppm

1990 NIOSH REL
TWA: 100 ppm (435 mg/m³)
STEL: 125 ppm (545 mg/m³)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m³)
STEL: 125 ppm (545 mg/m³)

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m³)
Category 1: local irritants
Peak Exposure Limit: 200 ppm, 5 min momentary value, max of 8/shift
Danger of cutaneous absorption

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 100 ppm/8 hr caused eye effects, sleep, and respiratory changes.
Human, lymphocyte: 1 mmol/L induced sister chromatid exchange.
Rat, oral, LD_{50}: 3500 mg/kg; toxic effects not yet reviewed
Rat (female), inhalation, TC_{Lo}: 1000 ppm/7 hr/day, 5 days/wk, for 3 wk prior to mating and daily for 19 days of gestation produced pups with high incidence of extra ribs.[179]

* See NIOSH, *RTECS* (DA0700000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 277 °F (136 °C)
Melting Point: -139 °F (-95 °C)
Surface Tension: 31.5 dyne/cm
Ionization Potential: 8.76 eV
Viscosity: 0.64 cP at 77 °F (25 °C)
Refraction Index: 1.4959 at 68 °F (20 °C)
Relative Evaporation Rate (ether = 1): 0.0106
Bulk Density: 7.21 lb/Gal at 77 °F (25 °C)
Critical Temperature: 651 °F (343.9 °C)
Critical Pressure: 35.6 atm
Molecular Weight: 106.16
Density: 0.863 at 77 °F (25 °C)
Water Solubility: Slightly, 14 mg/100 mL at 59 °F (15 °C)
Other Solubilities: Miscible in alcohol, ether; soluble in carbon tetrachloride, benzene, sulfur dioxide, and many organic solvents; insoluble in ammonia
Odor Threshold: 2.3 ppm
Vapor Pressure: 7.1 mm Hg at 68 °F (20 °C); 10 mmHg at 78.62 °F (25.9 °C); 100 mm H 165.38 °F (74.1 °C)
Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³): 0.0768 lb/ft³ or 1.2298 kg/m

Appearance and Odor: Colorless, flammable liquid with a pungent odor.

Section 4. Fire and Explosion Data

Flash Point: 64 °F (18 °C) CC	Autoignition Temperature: 810 °F (432 °C)	LEL: 1.0% v/v	UEL: 6.7% v/v

Extinguishing Media: Class 1B Flammable liquid. For small fires, use dry chemical, carbon dioxide, or 'alcohol-resistant' foam. For large fires, u fog or 'alcohol-resistant' foam. Use water only if other agents are unavailable; EB floats on water and may travel to an ignition source and spread fire. **Unusual Fire or Explosion Hazards:** Burning rate = 5.8 mm/min. Vapors may travel to an ignition source and flash back. Container may explode in heat of fire. EB poses a vapor explosion hazard indoors, outdoors, and in sewers. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demar or positive-pressure mode. Cool container sides with water until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Withdraw immediately if you hear rising soun from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Ethylbenzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardc polymerization cannot occur.
Chemical Incompatibilities: Reacts vigorously with oxidizers.
Conditions to Avoid: Exposure to heat and oxidizers.
Hazardous Products of Decomposition: Thermal oxidative decomposition of EB can produce acrid smoke and irritating fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list EB as a carcinogen. **Summary of Risks:** Occupational exposure to EB alor is rare since it is usually present together with other solvents. EB is irritating to the eyes, skin, and respiratory tract. Vapor inhalation produces varying degrees of CNS effects depending on concentration. The liquid is absorbed through the skin but vapors are not. 56 to 64% of inhaled ethylbenzene is retained and metabolized. Urinary metabolites following exposure to 23 to 85 ppm for 8 hr are mandelic acid (64%), phenylglyoxylic acid (25%), and methylphenylcarbinol/1-phenyl ethanol (5%). Concurrent exposure to xylene and ethylbenzene causes slower excretio of EB metabolites. Based on the rat LD_{50}, one manufacturer gives 3 to 4 oz. as the lethal dose for a 100 lb person.

Continue on next pa

Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Skin and CNS diseases and impaired pulmonary function (especially obstructive airway disease). **Target Organs:** Eyes, respiratory system, skin, CNS, blood. **Primary Entry Routes:** Inhalation, skin and eye contact. **Acute Effects:** Vapor inhalation of 200 ppm caused transient eye irritation; 1000 ppm caused eye irritation with profuse watering (tolerance developed rapidly); 2000 ppm caused severe and immediate eye irritation and watering, nasal irritation, chest constriction, and vertigo; 5000 ppm was intolerable and caused eye and nose irritation. Inhalation of high concentrations may cause narcosis, cramps, and death due to respiratory paralysis. Skin exposed to pure ethylbenzene for 10 to 15 min absorbed 22 to 33 mg/cm²/hr. Immersion of hand in solutions of 112 & 156 mg/L for 1 hr absorbed 118 & 215.7 μg/cm²/hr, respectively. **Chronic Effects:** Repeated skin contact may cause dryness, scaling, and fissuring. Workers chronically exposed to > 100 ppm complained of fatigue, sleepiness, headache, and mild irritation of the eyes and respiratory tract. Repeated vapor inhalation may result in blood disorders, particularly leukopenia (abnormally low level of white blood cells) and lymphocytosis.

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting! Aspiration of even a small amount of EB in vomitus can cause severe damage since its low viscosity and surface tension will cause it to spread over a large area of the lung tissue.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: BEI = mandelic acid in urine (1.5 g/g of creatinine), sample at end of shift at workweeks end. Since this test is not specific, test for EB in expired air for confirmation.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate and ventilate area, deny entry and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against vapor inhalation and skin/eye contact. Take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container. Dike far ahead of large spill for later reclamation or disposal. Report any release >1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, EB partially evaporates into the atmosphere, with a half-life of hrs to wks, and some leaches into groundwater, especially in soil with low organic carbon content. Biodegradation occurs with a half-life of 2 days. Some EB may absorb to sediment or bioconcentrate in fish. Evidence points to slow biodegradation in groundwater. In air, it reacts with photochemically produced hydroxyl radicals with a half-life of hrs to 2 days. Additional amounts may be removed by rain. ***Ecotoxicity Values:*** Shrimp (*Mysidopsis bahia*), LC_{50} = 87.6 mg/L/96 hr; sheepshead minnow (*Cyprinodon variegatus*) LC_{50} = 275 mg/L/96 hr; fathead minnow (*Pimephales promelas*) LC_{50} = 42.3 mg/L/96 hr in hard water & 48.5 mg/L/96 hr in softwater. **Disposal:** A candidate for rotary kiln incineration at 1508 to 2912°F (820 to 1600°C), liquid injection incineration at 1202 to 2912°F (650 to 1600°C), and fluidized bed incineration at 842 to 1796°F (450 to 980°C). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.21): No. D001
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311 (b)(4) & CWA, Sec. 307 (a)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use a powered air-purifying respirator with an appropriate organic vapor cartridge, a supplied-air respirator (SAR), SCBA, or chemical cartridge respirator with appropriate organic vapor cartridge. For < 2000 ppm, use a SAR or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of Viton or polyvinylchloride to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a cool, dry, well-ventilated area away from ignition sources and oxidizers. Outside or detatched storage is preferred. If inside, store in a standard flammable liquids cabinet. Containers should have flame-arrester or pressure-vacuum venting. To prevent static sparks, electrically ground and bond all equipment used with ethylbenzene. Install Class 1, Group D electrical equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain levels as low as possible. Purge and ventilate reaction vessels before workers are allowed to enter for maintenance or cleanup. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, skin, blood, and respiratory system.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Ethylbenzene
DOT Hazard Class: 3
ID No.: *UN1175*
DOT Packing Group: II
DOT Label: Flammable liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) **Exceptions:** 173.150
b) ***Non-bulk Packaging:*** 173.202
c) **Bulk Packaging:** 173.242

Quantity Limitations
a) **Passenger Aircraft or Railcar:** 5L
b) ***Cargo Aircraft Only:*** 60 L

Vessel Stowage Requirements
a) **Vessel Stowage:** B
b) **Other:** —

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 153, 159, 162, 163, 164, 167, 168, 171, 176, 179

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** W Silverman, MD

Section 1. Material Identification

Toluene ($C_6H_5CH_3$) Description: Derived from petroleum i.e., dehydrogenation of cycloparaffin fractions followed by the aromatization of saturated aromatic hydrocarbons or by fractional distillation of coal-tar light oil and purified by rectification. Used widely as a solvent (replacing benzene in many cases) for oils, resins, adhesives, natural rubber, coal tar, asphalt, pitch, acetyl celluloses, cellulose paints and varnishes; a diluent for photogravure inks, raw material for organic synthesis (benzoyl & benzilidene chlorides, saccharine, TNT, toluene diisocyanate, and many dyestuffs), in aviation and high octane automobile gasoline, as a nonclinical thermometer liquid and suspension solution for navigational instruments.

Other Designations: CAS No. 108-88-3, Methacide, methylbenzene, methylbenzol, phenylmethane, toluol, Tolu-sol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Toluene is an eye, skin, and respiratory tract irritant becoming narcotic at high centrations. Liver and kidney damage has occurred. Pregnant women chronically exposed to toluene have shown teratogenic effects. Toluene is highly flammable.

R 1
I 3
S 2*
K 3
* Skin absorption

NFPA: 3 (flammability), 2 (health), 0 (reactivity), - (special)

HMIS
H 2- Chronic effects
F 3
R 0
PPE-Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Toluene, < 100%; may contain a small amount of benzene (~ 1%), xylene, and nonaromatic hydrocarbons.

1991 OSHA PELs
8-hr TWA: 100 ppm (375 mg/m^3)
15-min STEL: 150 ppm (560 mg/m^3)

1990 IDLH Level
2000 ppm

1990 NIOSH RELs
TWA: 100 ppm (375 mg/m^3)
STEL: 150 ppm (560 mg/m^3)

1992-93 ACGIH TLV (Skin)
TWA: 50 ppm (188 mg/m^3)

1990 DFG (Germany) MAK*
TWA: 100 ppm (380 mg/m^3)
Half-life: 2 hr to end of shift
Category II: Substances with systemic effects
Peak Exposure Limit: 500 ppm, 30 min average value, 2/shift

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: 100 ppm caused hallucinations, and changes in motor activity and changes in psychophysiological tests.
Human, oral, LD_{Lo}: 50 mg/kg; toxic effects not yet reviewed
Human, eye: 300 ppm caused irritation.
Rat, oral, LD_{50}: 5000 mg/kg
Rat, liver: 30 µmol/L caused DNA damage.

* Available information suggests damage to the developing fetus is probable.
†See NIOSH, *RTECS* (XS5250000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 232 °F (110.6 °C)
Melting Point: -139 °F (-95 °C)
Molecular Weight: 92.15
Density: 0.866 at 68 °F (20/4 °C)
Surface Tension: 29 dyne/cm at 68 °F (20 °C)
Viscosity: 0.59 cP at 68 °F (20 °C)
Refraction Index: 1.4967 at 20 °C/D
Water Solubility: Very slightly soluble, 0.6 mg/L at 68 °F (20 °C)
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, chloroform, glacial acetic acid, petroleum ether, and carbon disulfide.
Vapor Pressure: 22 mm Hg at 68 °F (20 °C); 36.7 mm Hg at 86 °F (30 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.0797 lb/ft^3 or 1.2755 kg/m^3
Odor Threshold (range of all referenced values): 0.021 to 69 ppm

Appearance and Odor: Colorless liquid with a sickly sweet odor.

Section 4. Fire and Explosion Data

Flash Point: 40 °F (4.4 °C) CC	Autoignition Temperature: 896 °F (480 °C)	LEL: 1.27% v/v	UEL: 7.0% v/v

Extinguishing Media: Toluene is a Class 1B flammable liquid. To fight fire, use dry chemical carbon dioxide, or 'alcohol-resistant' foam. Water spray may be ineffective as toluene floats on water and may actually spread fire. **Unusual Fire or Explosion Hazards:** Concentrated vapors are heavier than air and may travel to an ignition source and flash back. Container may explode in heat of fire. Toluenes' burning rate = 5.7 mm/min and its flame speed = 37 cm/sec. Vapor poses an explosion hazard indoors, outdoors, and in sewers. May accumulate static electricity. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing provides only limited protection. Apply cooling water to sides of tanks until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from fire and let burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire because a BLEVE (boiling liquid expanding vapor explosion) may be imminent. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Toluene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can't occur. **Chemical Incompatibilities:** Strong oxidizers, concentrated nitric acid, nitric acid + sulfuric acid, dinitrogen tetroxide, silver perchlorate, bromine trifluoride, tetranitromethane, and 1,3-dichloro-5,5-dimethyl-2,4-imidazolididione. **Conditions to Avoid:** Contact with heat, ignition sources, or incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of toluene can produce carbon dioxide, and acrid, irritating smoke.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list toluene as a carcinogen. **Summary of Risks:** Toluene is irritating to the eyes, nose, and respiratory tract. Inhalation of high concentrations produces a narcotic effect sometimes leading to coma as well as liver and kidney damage. 93% of inhaled toluene is retained in the body of which 80% is metabolized to benzoic acid, then to hippuric acid and excreted in urine. The remainder is metabolized to *o*-cresol and excreted or exhaled unchanged. Toluene metabolism is inhibited by alcohol ingestion and is synergistic with benzene, asphalt fumes, or chlorinated hydrocarbons (i.e. perchloroethylene). Toluene is readily absorbed through the skin at 14 to 23 mg/cm^2/hr. Toluene is absorbed quicker during exercise than at rest and appears to be retained longer in obese versus thin victims; presumably due to it[s] lipid solubility. There is inconsistent data on toluene's ability to damage bone marrow; chronic poisoning has resulted in anemia and leucopenia wi[th] biopsy showing bone marrow hypo-plasia. These reports are few and some authorities argue that the effects may have been due to benzene contaminants. Chronic inhalation during pregnancy has been associated with teratogenic effects on the fetus including microcephaly, CNS dysfunction, attentional deficits, developmental delay + language impairment, growth retardation, and physical defects including a small midface, short palpebra[l] fissures, with deep-set eyes, low-set ears, flat nasal bridge with a small nose, micrognathia, and blunt fingertips. There is some evidence that toluen[e] causes an autoimmune illness in which the body produces antibodies that cause inflammation of its own kidney.

Continue on next pa[ge]

Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism and CNS, kidney, skin, or liver disease. **Target Organs:** CNS, liver, kidney, skin. **Primary Entry Routes:** Inhalation, skin contact/absorption. **Acute Effects:** Vapor inhalation causes respiratory tract irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, watering eyes, nervousness, insomnia, parasthesis, and vertigo progressing to narcotic coma. Death may result from cardiac arrest due to ventricular fibrillation with catecholamines loss. Liquid splashed in the eye causes conjunctival irritation, transient corneal damage and possible burns. Prolonged skin contact leads to drying and fissured dermatitis. Ingestion causes GI tract irritation and ...ptoms associated with inhalation. **Chronic Effects:** Symptoms include mucous membrane irritation, headache, vertigo, nausea, appetite loss and ...nol intolerance. Repeated heavy exposure may result in encephalopathies (cerebellar ataxia and cognitive dysfunction), liver enlargement, and kidney dystrophy (wasting away). Symptoms usually appear at workdays end, worsen at weeks end and decrease or disappear over the weekend.

FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of danger of aspiration into the lungs. Gastric lavage may be indicated if large amounts are swallowed; potential toxicity needs to be weighed against aspiration risk when deciding for or against gastric lavage. **Note to Physicians:** Monitor cardiac function. If indicated, use epinephrine and other catecholamines carefully, because of the possibility of a lowered myocardial threshold to the arrhythmogenic effects of such substances. Obtain CBC, electrolytes, and urinalysis. Monitor arterial blood gases. If toluene has > 0.02% (200 ppm) benzene, evaluate for potential benzene toxicity. BEI: hippuric acid in urine, sample at shift end (2.5 g/g creatinine); Toluene in venous blood, sample at shift end (1.0 mg/L).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel protect against inhalation and skin/eye contact. Use water spray to cool and disperse vapors but it may not prevent ignition in closed spaces. Cellosolve, hycar absorbent materials, and fluorocarbon water can also be used for vapor suppression/containment. Take up small spill with earth, sand, vermiculite, or other absorbent, noncombustible material. Dike far ahead of large spills for later reclamation or disposal. For water spills, (10 ppm or greater) apply activated carbon at 10X the spilled amount and remove trapped material with suction hoses or use mechanical dredges/lifts to remove immobilized masses of pollutants and precipitates. Toluene can undergo fluidized bed incineration at 842 to 1796 °F (450 to 980 °C), rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C), or liquid injection incineration at 1202 to 2912 °F (650 to 1600 °C). Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Blue gill, LC_{50} = 17 mg/L/24 hr; shrimp (*Crangonfracis coron*), LC_{50} = 4.3 ppm/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 36.2 mg/L/96 hr. **Environmental Degradation:** If released to land, toluene evaporates and undergoes microbial degradation. In water, toluene volatilizes and biodegrades with a half-life of days to several weeks. In air, toluene degrades by reaction with photochemically produced hydroxyl radicals. **Disposal:** Treat contaminated water by gravity separation of solids, followed by skimming of surface. Pass through dual media filtration and carbon absorption units (carbon ratio 1 kg to 10 kg soluble material). Return waste water from backwash to gravity separator. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U220
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg)
...per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307 (a)]
...d as a SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses with shatter-resistant glass and side-shields or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use any chemical cartridge respirator with appropriate organic vapor cartridges, any supplied-air respirator (SAR), or SCBA. For < 2000 ppm, use any SAR operated in continuous-flow mode, any SAR or SCBA with a full facepiece, or any air-purifying respirator with a full facepiece having a chin-style, front or back mounted organic vapor canister. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl alcohol with a breakthrough time of > 8 hr, Teflon and Viton are recommended as suitable materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove toluene from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from ignition sources and incompatibles. Outside or detached storage is preferred. If stored inside, use a standard flammable liquids warehouse, room, or cabinet. To prevent static sparks, electrically ground and bond all equipment used with toluene. Do not use open lights in toluene areas. Install Class 1, Group D electrical equipment. Check that toluene is free of or contains < 1% benzene before use. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Adopt controls for confined spaces (29 CFR 1910.146) if entering areas of unknown toluene levels (holes, wells, storage tanks). Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, liver, kidney, and skin. Include hemocytometric and thrombocyte count in cases where benzene is a contaminant of toluene. Monitor air at regular intervals to ensure effective ventilation.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Toluene
DOT Hazard Class: 3
...: UN1294
...Packing Group: II
DOT Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 150
b) Non-bulk Packaging: 202
c) Bulk Packaging: 242

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
Vessel Stowage: B
Other: --

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 140, 148, 153, 159, 163, 164, 167, 169, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, CIH, MPH; **Medical Review:** AC Darlington, MD, MPH

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Material Safety Data Sheets Collection:

Sheet No. 318
Xylene *(Mixed Isomers)*

Issued: 11/80 Revision: E, 9/92 Errata: 12/94

Section 1. Material Identification

45

Xylene (Mixed Isomers) (C_8H_{10}) Description: The commercial product is a blend of the three isomers [*ortho*-(*o*-), *meta*-(*m*-), *para*-(*p*-)] with the largest proportion being *m*- xylene. Xylene is obtained from coal tar, toluene by transalkylation, and pseudocumene. Used in the manufacture of dyes, resins, paints, varnishes, and other organics; as a general solvent for adhesives, a cleaning agent in microscope technique; as a solvent for Canada balsam microscopy; as a fuel component; in aviation gasoline, protective coatings, sterilizing catgut, hydrogen peroxide, perfumes, insect repellants, pharmaceuticals, and the leather industry; in the production of phthalic anhydride, isophthalic, and terephthalic acids and their dimethyl esters which are used in the manufacture of polyester fibers; and as an indirect food additive as a component of adhesives. Around the home, xylene is found as vehicles in paints, paint removers, degreasing cleaners, lacquers, glues and cements and as solvent/vehicles for pesticides.

R 1
I 2
S 2
K 3

NFPA: 3 (top), 2 (left), 0 (right), – (bottom)

HMIS
H 2†
F 3
R 0
PPE ‡
† Chronic Effects
‡ Sec. 8

Other Designations: CAS No. 1330-20-7 [95-47-6; 108-38-3; 106-42-3 (*o*-, *m*-, *p*-isomers)], dimethylbenzene, methyltoluene, NCI-C55232, Violet 3, xylol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Xylene is an eye, skin, and mucous membrane irritant and may be narcotic in high concentrations. It is a dangerous fire hazard.

Section 2. Ingredients and Occupational Exposure Limits

Xylene (mixed isomers): the commercial product generally contains ~ 40% *m*-xylene; 20% each of *o*-xylene, *p*-xylene, and ethylbenzene; and small quantities of toluene. Unpurified xylene may contain pseudocumene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m³)
15-min STEL: 150 ppm (655 mg/m³)

1990 IDLH Level
1000 ppm

1990 NIOSH RELs
TWA: 100 ppm (435 mg/m³)
STEL: 150 ppm (655 mg/m³)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m³)
STEL: 150 ppm (651 mg/m³)
BEI (Biological Exposure Index): Methylhippuric acids in urine at end of shift: 1.5 g/g creatinine

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m³)
Category II: Substances with systemic effects
Half-life: < 2 hr
Peak Exposure: 200 ppm, 30 min. average value, 4 peaks per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 200 ppm produced olfaction effects, conjunctiva irritation, and other changes involving the lungs, thorax, or respiration.
Man, inhalation, LC_{Lo}: 10000 ppm/6 hr; toxic effects not yet reviewed.
Human, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted.
Rat, oral, LD_{50}: 4300 mg/kg; toxic effect not yet reviewed.
Rat, inhalation, LC_{50}: 5000 ppm/4 hr; toxic effects not yet reviewed.

* See NIOSH, *RTECS* (XE2100000), for additional toxicity data.

Section 3. Physical Data

Boiling Point Range: 279 to 284 °F (137 to 140 °C)*
Boiling Point: *ortho:* 291 °F (144 °C); *meta:* 281.8 °F (138.8 °C); *para:* 281.3 °F (138.5 °C)
Freezing Point/Melting Point: *ortho:* -13 °F (-25 °C); *meta:* -53.3 °F (- 47.4 °C); *para:* 55 to 57 °F (13 to 14 °C)
Vapor Pressure: 6.72 mm Hg at 70 °F (21 °C)
Saturated Vapor Density (Air = 1.2 kg/m³): 1.23 kg/m³, 0.077 lbs/ft³
Appearance and Odor: Clear, sweet-smelling liquid.

Molecular Weight: 106.16
Specific Gravity: 0.864 at 20 °C/4 °C
Water Solubility: Practically insoluble
Other Solubilities: Miscible with absolute alcohol, ether, and many other organic liquids.
Octanol/Water Partition Coefficient: logKow = 3.12-3.20
Odor Threshold: 1 ppm
Viscosity: <32.6 SUS

* Materials with wider and narrower boiling ranges are commercially available.

Section 4. Fire and Explosion Data

Flash Point: 63 to 77 °F (17 to 25 °C) CC	Autoignition Temperature: 982 °F (527 °C) (*m*-)	LEL: 1.1 (*m*-, *p*-); 0.9 (*o*-)	UEL: 7.0 (*m*-, *p*-); 6.7 (*o*-)

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray or regular foam. For large fires, use water spray, fog or regular foam. Water may be ineffective. Use water spray to cool fire-exposed containers. **Unusual Fire or Explosion Hazards:** Xylene vapors or liquid (which floats on water) may travel to an ignition source and flash back. The heat of fire may cause containers to explode and/or produce irritating or poisonous decomposition products. Xylene may present a vapor explosion hazard indoors, outdoors, or in sewers. Accumulated static electricity may occur from vapor or liquid flow sufficient to cause ignition. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing will provide limited protection. If feasible and without risk, move containers from fire area. Otherwise, cool fire-exposed containers until well after fire is extinguished. Stay clear of tank ends. Use unmanned hose holder or monitor nozzles for massive cargo fires. If impossible, withdraw from area and let fire burn. Withdraw immediately in case of any tank discoloration or rising sound from venting safety device. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Xylene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Xylene is easily chlorinated, sulfonated, or nitrated. **Chemical Incompatibilities:** Incompatibilities include strong acids and oxidizers and 1,3-dichloro-5,5-dimethyl-2,4-imidazolidindione (dichlorohydrantoin). Xylene attacks some forms of plastics, rubber, and coatings. **Conditions to Avoid:** Avoid heat and ignition sources and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of xylene can produce carbon dioxide, carbon monoxide, and various hydrocarbon products.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list xylene as a carcinogen. **Summary of Risks:** Xylene is an eye, mucous membrane, and respiratory tract irritant. Irritation starts at 200 ppm; severe breathing difficulties which may be delayed in onset can occur at high concentrations. It is a central nervous system (CNS) depressant and at high concentrations can cause coma. Kidney and liver damage can occur with xylene exposure. With prolonged or repeated cutaneous exposure, xylene produces a defatting dermatitis. Chronic toxicity is not well defined, but it is less toxic than benzene. Prior to the 1950s, benzene was often found as a contaminant of xylene and the effects attributed to xylene such as blood dyscrasias are questionable. Since the late 1950s, xylenes have been virtually benzene-free and blood dyscrasias have not been associated with xylenes. Chronic exposure to high concentrations of xylene in animal studies have demonstrated mild reversible decrease in red and white cell counts as well as increases in platelet counts.

Continue on next page

Section 6. Health Hazard Data, *continued*

Menstrual irregularity was reported in association with workplace exposure to xylene perhaps due to effects on liver metabolism. Xylene crosses the human placenta, but does not appear to be teratogenic under conditions tested to date. **Medical Conditions Aggravated by Long-Term Exposure:** CNS, respiratory, eye, skin, gastrointestinal (GI), liver and kidney disorders. **Target Organs:** CNS, eyes, GI tract, liver, kidneys, and skin. **Primary Entry Routes:** Inhalation, skin absorption (slight), eye contact, ingestion. **Acute Effects:** Inhalation of high xylene concentrations may cause dizziness, nausea, vomiting, and abdominal pain; eye, nose, and throat irritation; respiratory tract irritation leading to pulmonary edema (fluid in lung); drowsiness; and unconsciousness. Direct eye contact can result in conjunctivitis and corneal burns. Ingestion may cause a burning sensation in the oropharynx and stomach and transient CNS depression. **Chronic Effects:** Repeated or prolonged skin contact may cause drying and defatting of the skin leading to dermatitis. Repeated eye exposure to high vapor concentrations may cause reversible eye damage, peripheral and central neuropathy, and liver damage. Other symptoms of chronic exposure include headache, fatigue, irritability, chronic bronchitis, and GI disturbances such as nausea, loss of appetite, and gas.

FIRST AID *Emergency personnel should protect against exposure.* **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing as it may pose a fire hazard. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. Monitor exposed person for respiratory distress. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, *do not induce vomiting!* If spontaneous vomiting should occur, keep exposed person's head below the hips to prevent aspiration (breathing liquid xylene into the lungs). *Aspiration of a few millimeters of xylene can cause chemical pneumonitis, pulmonary edema, and hemorrhage.* **Note to Physicians:** Hippuric acid or the ether glucuronide of *ortho*-toluic acid may be useful in diagnosis of *meta*-, *para*- and *ortho*-xylene exposure, respectively. Consider gastric lavage if a large quantity of xylene was ingested. Proceed gastric lavage with protection of the airway from aspiration; consider endotracheal intubation with inflated cuff.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and ventilate spill area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If feasible and without undue risk, stop leak. Use appropriate foam to blanket release and suppress vapors. Water spray may reduce vapor, but does not prevent ignition in closed spaces. For small spills, absorb on paper and evaporate in appropriate exhaust hood or absorb with sand or some non-combustible absorbent and place in containers for later disposal. For large spills dike far ahead of liquid to contain. Do not allow xylene to enter a confined space such as sewers or drains. On land, dike to contain or divert to impermeable holding area. Apply water spray to control flammable vapor and remove material with pumps or vacuum equipment. On water, contain material with natural barriers, booms, or weirs; apply universal gelling agent; and use suction hoses to remove spilled material. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** Little bioconcentration is expected. Biological oxygen demand 5 (after 5 days at 20 °C): 0.64 (no stated isomer). **Ecotoxicity values:** LD_{50}, Goldfish, 13 mg/L/24 hr, conditions of bioassay not specified, no specific isomer. **Environmental Degradation:** In the atmosphere, xylenes degrade by reacting with photochemically produced hydroxyl radicals with a half-life ranging from 1-1.7 hr. in the summer to 10-18 hr in winter or a typical loss of 67-86% per day. Xylenes are resistant to hydrolysis. **Soil Absorption/Mobility:** Xylenes have low to moderate adsorption to soil and when spilled on land, will volatilize and leach into groundwater. **Disposal:** As a hydrocarbon, xylene is a good candidate for controlled incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U239, F003 (spent solvent)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4); per RCRA, Sec. 3001]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations >1000 ppm, use any chemical cartridge respirator with organic vapor cartridges; any powered, air-purifying respirator with organic vapor cartridges; any supplied-air respirator; or any self-contained breathing apparatus. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. With breakthrough times > 8 hr, consider polyvinyl alcohol and fluorocarbon rubber (Viton) as materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in clearly labelled, tightly closed, containers in a cool, well-ventilated place, away from strong oxidizing materials and heat and ignition sources. During transferring operations, electrically ground and bond metal containers. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Use hermetically sealed equipment, transfer xylene in enclosed systems, avoid processes associated with open evaporating surfaces, and provide sources of gas release with enclosures and local exhaust ventilation. Use Class I, Group D electrical equipment. **Administrative Controls:** Establish air and biological monitoring programs and evaluate regularly. Consider preplacement and periodic medical examinations including a complete blood count, a routine urinalysis, and liver function tests. Consider hematologic studies if there is any significant contamination of the solvent with benzene. If feasible, consider the replacement of xylene by less toxic solvents such as petrol (motor fuel) or white spirit. Before carrying out maintenance and repair work, steam and flush all equipment to remove any xylene residues.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Xylenes
DOT Hazard Class: 3
ID No.: UN1307
DOT Packing Group: II
DOT Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 173.150
b) Nonbulk Packaging : 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: –

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 171, 174, 176, 180

Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** W Silverman, MD j Response to Comments

MWH
MONTGOMERY WATSON HARZA

December 27, 2001

Kevin Adler
Remedial Project Manager
U.S. Environmental Protection Agency
Region V, SR-6J
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Re: Response to Comments on Draft Revised Long-Term Groundwater Monitoring Plan
American Chemical Service, Inc. NPL Site, Griffith, Indiana

Dear Mr. Adler:

MWH has received comments from both the U.S. EPA and IDEM on the Draft Revised Long-Term Groundwater Monitoring Plan (the Plan) submitted in September 2001 for the American Chemical Service, Inc. (ACS) NPL Site in Griffith, Indiana. Thank you for sending the files in electronic format. We have included both sets of comments below in bold face type and followed each comment with a response and description of proposed action. Our responses include those decisions agreed to during our meeting held at the Site on November 29, 2001.

RESPONSE TO U.S. EPA COMMENTS

1. **General recommendation, Aquifer Characteristics: A benefit of such a large amount of data would be to incorporate the data to determine the true relationship between the upper and lower aquifers. The document points out the need for determining the extent of the confining layer. As stated, "It is less than five feet thick northwest of the Site." (near MW10C); also note that MW10C and other wells in this area have exceeded the baseline concentrations in recent sampling events, even though supplemental extraction activities have taken place in these wells. A clear picture (e.g., cross sectional drawings of the upper and lower aquifer which incorporate the area inside and outside the barrier wall) has not been established.**

   MWH's policy during all past investigations at the Site has been to avoid drilling through the confining clay layer in areas where there are high contaminant concentrations. The policy has been consistently supported by the Agencies. One result of the policy is that we do not have specific stratigraphic data for the confining layer and the lower aquifer within the barrier wall area. Three cross-sectional drawings have been developed during past investigations (Attachment A). Section C-C' is the only one that crosses the ACS Site. Because of the lack of borings within the area enclosed by the barrier wall, the stratigraphy in this zone is interpolated from borings outside the barrier wall. Several borings near the edge of the Site (ATMW4D, MW56) have shown that the confining clay layer is more than 10 feet thick at the northwest corner of the ACS facility.

During drilling for the installation at MW-10C the driller experienced difficulties with flowing sands at the bottom of the upper aquifer. Three borings were made in the general MW-10 area. The first two were labeled MW-10A and MW-10B, respectively. These along with the boring log for MW-10C can be found in Appendix D of the RI Report. Since sands flowed into the hollow stem auger, it was difficult to get a split-spoon sample from the location. However, at these three locations, we did get a consistent indication of at least four feet of clay, located between the depths of 13 and 20 feet below ground surface.

2. **Page 1, Section 1.0, 4th paragraph. Has the QAPP, dated March 2001, been approved? May need to check the cross-referencing between the Revised Long-Term Groundwater Monitoring Plan (RLTGMP) and the QAPP, and vice versa.**

   MWH understands that the QAPP, dated November 2001, was approved on November 19, 2001. All cross-referencing has been checked.

3. **Page 2, Section 2.1.1, 1st paragraph. Insert the words *and lacustrine* in the last sentence: "The two aquifers and the clay confining layer comprise the approximately 100 feet of alluvial *and lacustrine* material overlying the bedrock."**

   Alluvial is a term meaning unconsolidated sediments, and as such, the term already includes lacustrine material. It would be redundant to say "alluvial and lacustrine."

4. **Page 2, Section 2.1.1, 3rd paragraph. "Borings at the perimeter of the ACS facility indicate that the clay confining layer is approximately ten or more feet thick beneath the ACS facility itself." Please provide data establishing this condition across the site. BVSPC believes there are large gaps in the data as to exactly how thick the confining layer is across the onsite area.**

   The text has been changed to state, "the clay confining layer could be ten or more feet thick." Also see response to comment #1.

5. **Page 2, Section 2.1.1, 3rd paragraph, 4th sentence. Add *feet* after *25*.**

   The text has been revised accordingly.

6. **Page 3, Section 2.2.1 Objectives, bullet 1. Before leaving the existing Interim Groundwater Monitoring Plan, all objectives of the plan should be met (or continued in the RLTGMP). The hydraulic gradient between the upper and lower aquifers in the northern and northeastern portions of the site has not been established in the area where the confining clay layer is less then 5 feet thick. Accordingly, this objective should be incorporated in Section 3.1, the Objectives section of the RLTGMP (See Comment No. 16).**

   Five years of data has established the vertical gradient at well pairs north, east, southeast, and northwest of the site. In general, the water table elevation is between 630 and 635 feet above mean sea level and the groundwater elevation in the lower aquifer is within a couple of feet of 620. As a result there is a generally a ten-foot drop, plus or minus three feet, across the clay confining layer. This head drop varies from season to season and from one location to another, but the range is consistent.

We calculated the magnitude of the hydraulic gradient with the equation: $i = \Delta h / \Delta t$. The variability of the head is one component. However, the other component, the thickness of the clay is far more variable than the difference in water level. Therefore, it is the clay thickness that leads to the high variability in the magnitude of calculated hydraulic gradient from one location to another. We have not thought that this variability shows a lack of understanding of site hydraulics. We believe that the water level data, dating from the RI in 1988, have provided sufficient documentation of hydraulic gradients between upper and lower aquifers. Therefore, as recommended in the proposed monitoring plan, we believe that it is reasonable to view this objective as having been met.

7. **Page 5, Section 2.2.3 Findings. Five years of analytical results have demonstrated that the water quality in some wells is quite *variable*–spikes of high concentrations are observed relative to lower concentrations in previous and subsequent sampling events. Several wells show a consistent seasonal variability.**

   Variability is one of the common characteristic of VOCs in a water table aquifer. These "variable" results are found in only a few wells, and are for the most part, attributable to seasonal variations. For the majority of data collected, consistent concentrations are found. To clarify, the following text has been added to the bulleted list on page 5:

   - *Concentrations at a few wells exhibit variable results that are, for the most part, attributable to seasonal variations. These wells are located in the internal part of the plume.*

8. **Page 5, Section 2.2.3.2 Groundwater Contaminants. Neither this section nor Tables 1 or 2 address the inorganic compounds found (especially arsenic and lead) in either the lower or upper aquifers. Analytical data for inorganic parameters should be included in the RLTGMP so reviewers can ascertain whether detected concentrations pose an unacceptable risk; pertinent inorganic parameters should be included in the new monitoring plan (see Comment No. 20).**

   The purpose of Tables 1 and 2 was to evaluate contaminants of concern (COCs) by their frequency of detection. For organic compounds, especially VOCs, occurrence is evidence of contamination. However, many inorganic compounds are naturally occurring and so occurrence alone is not evidence of contamination. Several metals including arsenic and lead were included as COCs during the risk assessment phase. However ultimately, the COCs for the site were identified as organic compounds. The occurrence of metals such as arsenic and lead appears to be related to the changes in aquifer chemistry rather than evidence of that lead and arsenic are contaminants migrating from the site in the groundwater.

   Based on the November 29, 2001 meeting, MWH has completed a comparison of all detections of arsenic and lead to U.S. EPA Maximum Contaminant Levels (MCLs) for these compounds. Monitoring wells that show exceedances of the MCLs will continue to be monitored for these compounds. Please see the response to Comment #20 for a discussion of the results.

9. **Page 6, Section 2.2.3.2, Upper Aquifer. Add the word *See* to heading, so that it reads Upper Aquifer (*See* Table 1).**

   The word "See" has been added to the text on page 6.

10. **Page 6, Section 2.2.3.2, Upper Aquifer, 2nd bullet. The detections of methylene chloride and acetone were attributed to lab-related activities. This has not been established through the use of trip blanks or field blanks.**

As the text states, two sampling events accounted for 66% of the detections. These events were June 1999 and March 2000. During those sampling events, methylene chloride and acetone were detected in the field blank, trip blank, and method blank samples. We have interpreted this to indicate that there was laboratory contamination, and that the detections in the samples were not related to site conditions.

Per our November 29 meeting, MWH has evaluated detections of these compounds outside of these two sampling rounds. There were no exceedances of the Region 9 PRG value for acetone (610 µg/L) outside of the two rounds mentioned above (U.S. EPA recommended comparing results to Region 9 PRG values). There were several exceedances of the U.S. EPA MCL for methylene chloride (5 µg/L), however, the only exceedances after 1997 were during the two rounds discussed above. Validation also flagged several of the 1996 and 1997 methylene chloride results as possibly related to laboratory contamination.

11. **Page 6, Section 2.2.3.2, Upper Aquifer, 5th bullet. MW06 and MW45 are referred to as *interior* wells. Clarify that these wells are inside the *plume* (and not inside the *site, barrier wall* or other areas).**

The text has been modified as suggested.

12. **Page 6, Section 2.2.3.2, Upper Aquifer, 7th bullet. Detections of phenols and bis(2-ethlhexyl)phthalate are attributed to the tubing in the wells; however, this was never confirmed by using field blanks in the sampling events.**

Detections of phenols and bis(2-ethylhexyl)phthalate *have* been confirmed by using field blanks. Please refer to the letter report, "*Results of Analytical Testing of PVC Tubing*," dated April 9, 1998. The test demonstrated that phenols and phthalates can be added to the samples when using PVC tubing. The vast majority of detections of these compounds occurred prior to 1998, when PVC tubing was used. Therefore, we believe it is reasonable to not include these compounds in the Plan.

13. **Page 7, Section 2.2.3.2, Lower Aquifer. Add the word *see* to heading, so that it reads Lower Aquifer (*See* Table 2).**

The text has been revised as suggested.

14. **Page 8, Section 2.2.3.2, Groundwater Contaminants, 2nd paragraph. This summary paragraph implies that benzene and chloroethane are indicator VOCs for all other chemicals of concern at the site even though previous statements confirm that "several compounds [have been] detected. . .in random assortments of wells, *rather that at wells with detections of benzene and chloroethane* [italics added]." The use of benzene and chloroethane is continued in Tables 3 and 4 and in the Concentration-vs-Time Plots in Appendix A to draw various conclusions about the contamination in the groundwater. The conclusions reached regarding benzene and chloroethane contamination in the groundwater have not been demonstrated as being representative of other site contaminants in the groundwater.**

We believe that the results from 14 years of sampling have shown that benzene and chloroethane are the primary COCs in groundwater at the site. The point of the referenced statement was to show that detections of other compounds are not considered significant, because they:

- Are not detected consistently at the same wells.
- Are detected at very low concentrations below respective MCLs.
- Are not detected exclusively at wells with consistent detections of benzene and chloroethane.

MWH has included with this letter, ten figures that show the spatial distribution of several VOCs (Attachment B). The VOCs chosen for the figures were those in Table 1 with 10 or more detections (Methylene chloride and acetone were not included per our response to Comment #10). The figures identify the locations of all historical detections of these VOCs (Squares (orange color) indicate concentrations above 10 µg/L, and circles (yellow color) indicate concentrations below 10 µg/L). MWH believes that these figures clearly demonstrate that benzene and chloroethane define the plume and are the primary COCs at the Site. MWH has not identified specific contaminants that consistently occur outside the plume as it has been delineated by the benzene and chloroethane detections.

The focus on benzene and chloroethane during the rest of the Plan is based on this evaluation. Tables 3 and 4 and Appendix A were intended to simplify the large amount of data present for the Site. We have changed any text that may imply that only Tables 3 and 4, and not a complete evaluation of all data, were used to demonstrate points in the text. We do not believe it would be beneficial to expand Tables 3 and 4 to include all compounds at this time.

15. **Page 9, Section 2.3, 3rd paragraph. This paragraph implies that all concentrations of contaminants in the lower aquifer are related to faulty well construction. However, this is not the case at MW10C. Please explain the elevated detections and additional purging of this well. A full understanding of the groundwater systems must be included in order to determine a modification in the LTGMP.**

It is clear that the presence of chloroethane and benzene in the lower aquifer is the result of migration from the upper aquifer. We have assumed that their presence is due to faulty well construction at MW9 and ATMW4D.We believe that these assumptions have been confirmed by the fact that concentrations in the lower aquifer decreased after these two wells were abandoned. We have recommended the installation of the new well (MW-56) and continued monitoring farther down gradient in the lower aquifer. If ongoing monitoring at these locations does not confirm this conclusion, it will be appropriate to develop a further response to this comment. We did not intent to imply that faulty well construction was present at MW10C. Because of the hydraulic gradient in the lower aquifer, it has been our thought that the leakage at MW09 was the source of benzene and chloroethane detected at MW10C. We have added text to clarify this issue.

16. **Page 10, Section 3.1, Objectives. Insert a 6th objective to define the vertical gradient between the upper and lower aquifers, especially in areas where they are separated by a thin clay confining layer. See Comment No. 6.**

As clarified in the response to comment 6, MWH believes that the vertical gradient between upper and lower aquifer is well documented. The fact that the gradient is variable is related to the variability in upper and lower aquifer water levels, as well as the degree of variability in the thickness of the clay confining layer. MWH does not equate variability with uncertainty in this case.

17. **Page 11, Section 3.2.1 Water Level Measurements (and Tables 5 and 6). Additional water level measurements should be made upgradient, downgradient, and close inside and outside of the barrier wall. For the Upper Aquifer, add the wells in the landfill M1S and M4S and piezometers P9, P13, P39, P40, P49, P51, and P52. In the Lower Aquifer, add M-4D.**

Based on the November 29 meeting, monitoring wells M4S and M4D and piezometers P13 and P17 have been added to the long-term monitoring plan. These locations will be included as long as they exist. These are on Town of Griffith property in the landfill and MWH will not be responsible to replace them if damaged or destroyed.

18. **Page 11, Section 3.2.1, Water Level Measurements, 3rd paragraph, 3rd sentence. Insert the word *not* so that the sentence reads: "... show which wells are *not* recommended...."**

The text has been revised accordingly.

19. **Page 11, Section 3.2.2, Sampling Parameters, 1st paragraph, 1st sentence. Correct the word *one* to read *once*.**

The text has been revised accordingly.

20. **Page 12, Section 3.2.2, Sampling Parameters, 2nd paragraph. Groundwater samples should be analyzed for all chemicals that have exceeded the baseline concentrations– including inorganic compounds–as well as those chemicals that contribute most to the exposure risk to persons at and surrounding the site. In addition to the VOCs listed on Page 12, groundwater samples should be analyzed for ethylbenzene and bis(2-ethylhexyl)phthalate. These constituents were identified as contaminants of concern in the baseline risk assessment and have been detected at concentrations exceeding their respective federal maximum contaminant levels (MCLs). At a minimum (pending preparation of a summary of inorganic concentrations [see Comment No. 8]), groundwater samples should also be analyzed for arsenic, cadmium, and lead since these metals were identified in the baseline risk assessment as being detected at concentrations exceeding their MCLs or action levels.**

We do not agree that a complete and comprehensive groundwater monitoring plan must analyze all chemicals that have ever exceeded a baseline concentration. We believe that fully protective groundwater monitoring plan can eliminate the analysis of chemicals or compounds that can be represented by surrogates or that are unrelated to the migration of contaminants from the site.

The most recent exceedance of ethylbenzene was in 1994 at monitoring well MW06. Ethylbenzene is a common constituent of gasoline, and monitoring well MW06 is adjacent to the UST area at the Town of Griffith Landfill. Furthermore, the USTs were removed in 1994, which corresponds with the most recent exceedence of ethylbenzene in 1994. All detections since 1994 at MW06 have been below the MCL of 700 ug/l. Therefore, we believe it is reasonable to eliminate ethylbenzene from the long term monitoring program.

As discussed in the response to comment 12, a study was conducted that showed bis(2-ethylhexyl)phthalate was correlated to the use of PVC. (See the letter report, "*Results of Analytical Testing of PVC Tubing*," dated April 9, 1998). The majority of detections of phthalates occurred prior to 1998 when PVC tubing was used. It is therefore reasonable to conclude that phthalates detections are not representative of the ACS groundwater and therefore eliminate them from the long-term groundwater monitoring program.

Per our November 29 meeting, all detections of arsenic, cadmium, and lead were compared to U.S. EPA MCLs and we have made the following observations:

- Most exceedances of lead occurred during 1996 and 1997. From 1998 through 2001, only 2 exceedances of the MCL have occurred, and these occurred in two different lower aquifer wells. Thus, no wells have been included for lead analysis in the revised monitoring plan.

- The most consistent exceedances of arsenic have occurred in monitoring wells MW06, MW15, and MW43. MW06 is internal to the plume, which extends south from the site. MW43 is at the far end of the plume extending south, and MW15 is on the south corner of the Town of Griffith landfill. These wells are not located along a single groundwater migration pathway. But each well is in an area in which the naturally occurring arsenic could be released by biological action in the aquifer. Other exceedances of arsenic have occurred at monitoring wells MW52, MW14, and MW49; at MW52, detections have been below 10 μg/L every time it has been sampled for the past 3 years; at MW14 and MW49, each well has only one exceedance historically. Thus MWH proposes to add analysis of arsenic annually at monitoring wells MW06, MW15, and MW43.

- There have been no exceedances of the MCL for cadmium at any monitoring network wells. Therefore, there is not a technical basis for including cadmium as a monitored parameter for the ACS site in the long term groundwater monitoring plan.

It was also decided during the meeting that all samples will be analyzed for full-scan parameters (VOCs, SVOCs, PCBs, pesticides, and inorganics) once during 2003 and 2006.

21. **Pages 12, 13, and 14. Sections 3.2.2 through 3.2.6 are incorrectly numbered. These should be corrected to read Sections 3.3.*3* through 3.2.*7*. [Subsequent comments will reference both the incorrect and corrected section numbers, as follows: 3.2.2[3].]**

    The section numbers have been corrected.

22. **Page 12, Section 3.2.2[3], Sampling Frequency, 2nd paragraph. MWH proposes sampling the reduced group of wells once every 9 months to provide *annual* data that reflects seasonal effects. This is a reasonable approach for long-term monitoring. However, BVSPC believes the change from quarterly, semiannual, and annual sampling of the current LTGMP to a proposed single sampling event only once per "year" is too abrupt a change. BVSPC proposes a transition from the current to the new monitoring plan wherein the reduced number of wells would be sampled quarterly for 1 year (four sampling events) to provide a new baseline– after construction of the many recent remedial actions–that incorporates seasonal effects. Baseline sampling parameters are discussed in Comment No. 28 below. After the 1-year baseline period, implement the RLTGMP 9-month sampling frequency, as proposed. Without the new baseline, it will be 3 years before data are collected in the 1st quarter of 2004, and 3 more years before data are collected for comparison in the same quarter–more than 6 years from the present.**

    Based on the November 29 meeting, the existing baseline will continue to be used for evaluation during the revised Plan. Also, a semi-annual sampling frequency will be conducted until the Groundwater Remedy has begun. It is anticipated that the proposed Groundwater Remedy will be submitted during 2002. It will include further revisions to the groundwater monitoring plan, and may reduce sampling frequency to once per year.

23. **Page 12, Section 3.2.3[4], Upper Aquifer Monitoring Locations, 2nd paragraph. The number of wells proposed for sampling for the North and West plume is not adequate, especially since there are almost no downgradient wells to detect any contaminant migration from the site. Five additional wells should include MW12 and MW39 (upgradient), and MW13, MW37, and M4S (downgradient). In addition, the justification for limiting the number of wells references Table 3 as evidence that site-related contaminants have not been found in these wells. Since Table 3 only lists two contaminants, it does not support the statement. See related discussion in Comment No. 14 above regarding the drawing of conclusions based on only these two chemicals.**

    The proposed changes to the Interim Monitoring Plan were based upon the many rounds of data collected over the past five years, as summarized in the References section. MWH intended Table 3 to show a summary of these results. MWH has changed the wording in the text to avoid confusion that revisions to the monitoring plan were based on Table 3.

    - Based on the November 29 meeting, <u>we have added monitoring wells MW37, MW39, and MW12 to the monitoring network</u>. These wells will be sampled once annually. Attached are updated Tables 8 and 10 from the revised Plan (Attachment C) which show the proposed schedule.

24. **Page 13, Section 3.2.3[4], Upper Aquifer Monitoring Locations, 1st paragraph. MW17 is proposed as the upgradient well for the South plume. This well has not been regularly sampled (only three times in 11 years) and may need to be redeveloped. In addition, MW18 may be a better selection as an upgradient well in that it has always been upgradient and has a longer history of sampling. MW18, however, will also require redevelopment.**

    MWH believes that, due to its condition, monitoring well MW18 cannot and should not be redeveloped, but rather should be abandoned. The well is flush mounted and is located in a driveway. It appears that automobile traffic over the well has ruptured the well screen, allowing it to fill with gravel. It is not our experience that development would return the well to full function.

    MW18 was selected for the monitoring network originally because it marked the outer extent of the groundwater plume. Over the past five years, and since the installation of the barrier wall, the plume extent has decreased, and it is now reasonable to designate MW17 to take the place of MW18. It seemed unnecessary for MWH to replace MW18, when MW17 will adequately represent the outer extent of the plume at that location.

25. **Page 13, Section 3.2.4[5], Lower Aquifer Monitoring Locations, 2nd paragraph. Change the word *site* to read "... monitor the interior of *the plume*, where. . . ."**

    The text has been revised accordingly.

26. **Page 14, Section 3.2.5[6]. The RLTGMP does not include any prior notification to USEPA and IDEM for residential well sampling activities. Also, BVSPC recommends that the residential well sampling be performed on a 9-month frequency–same as that proposed for the monitoring well sampling–so as to include seasonal variability in the residential well sampling program.**

    The text has been revised to include a notification to USEPA and IDEM four weeks prior to the planned event.

Based on the semi-annual sampling frequency determined during the November 29 meeting, the residential wells will be sampled annually during the 3rd quarter sampling event every year.

27. **Page 14, Section 3.3.2, Analytical Results, 1st paragraph, 2nd sentence. Correct Table *10* to read Table *12*.**

The text has been revised accordingly.

28. **Page 14, Section 3.3.2, Analytical Results, 1st paragraph. The RLTGMP proposes development of a new baseline for the compounds. The baseline proposed in Table 12 increases the baseline concentrations for some wells above those in the current baseline, but only for benzene and chloroethane–not other chemicals that should be monitored (see Comment No. 20). The proposed baseline incorporates the highest previously detected concentration for each compound, even if it exceeds the current baseline value. BVSPC recommends that a new full scan round of the reduced set of 17 wells should take place to establish a new baseline for all chemicals. The new baseline concentrations, however, should not exceed those of the current baseline; rather, they should be reduced to the maximum concentrations measured in each well in the four new baseline quarterly sampling rounds.**

MWH has reconsidered the concept of defining a new baseline in light of these review comments. As stated in the response to comment #22 we believe that the existing baseline is adequate to serve as the baseline for the revised Plan.

29. **Page 14, Section 3.3.2, Analytical Results, 1st bullet. The Plan proposes allowing exceedances of baseline values (up to 25% or 10 µg/L) without requiring any corrective action. BVSPC believes that any exceedance of the baseline values shall initiate a corrective action. Accordingly, revise the 1st bullet to read: "If the concentration exceeds the baseline by *any amount up to 50% or 20 µg/L*, whichever is higher, then the well will be resampled for TCL VOCs *and other "new sampling parameters" identified in Comment No. 20* within four weeks of the completion of data validation."**

For the last five years, MWH has understood that an exceedance requires a response, and not necessarily a corrective action. Based on the November 29 meeting, the text will be changed to state that any exceedance will require a response. The response will provide the data and an explanation to the agencies. Given the magnitude and location of the exceedance, the response might also include re-sampling or proposing a specific corrective action.

30. **Page 14, Section 3.3.2, Analytical Results, 3rd paragraph, 2nd sentence. Revise the word *may* to *shall* so that the sentence reads: "If results continue to exceed the baseline values, then further corrective action *shall* be proposed, which may include continued monitoring." The response to resample the well and to continue to monitor it does not complete a corrective action; this is only the initial step. Additional actions are required to identify, assess, and/or control the source of the exceedance.**

The text has been revised accordingly.

31. **Page 15, Section 3.4 Reporting. The "annual" groundwater monitoring report should be submitted within a specified amount of time (e.g., 30 days) after data validation is complete. It should not be delayed until a specific date, as proposed.**

Based on the November 29 meeting, an annual report will be submitted within 60 days after validation is complete.

32. **Tables 1 and 2. No data are presented regarding the inorganic parameters sampled and analyzed for.**

See response to comment #8.

33. **Table 3. No data are presented for MW17 although data in Appendix A indicates MW17 was sampled in June 2001. Data are presented for the June 2001 sampling event for MW18, but Appendix A indicates MW18 was not sampled.**

Table 3 was included in the plan specifically to list only the wells which are part of the current monitoring network. We have corrected the table to indicate that MW18 was last sampled in June 1999, and MW15 was last sampled in June 2001. MW17 is not part of the current monitoring network and therefore it does not appear on the table.

34. **Table 5. Update Table 5 to reflect the installation and replacement of piezometers in the OFCA. Delete shading and add "X" in "OBJ #1" column for the additional water level measuring locations identified in Comment No. 17.**

Table 5 has been updated to reflect the recent piezometers installed. Please see response to comment #17.

35. **Table 6. Delete shading and add "X" in "OBJ #1" column for the additional water level measuring location identified in Comment No. 17.**

The table has been modified to reflect the additional locations identified in the response to comment #17.

36. **Table 7. MW17 is identified as fulfilling the Interior OBJ #5, but Figure 3 indicates it not interior, but rather fulfills the Upgradient OBJ #3. Correct Table 7 or Figure 3. Update Table 7 and Figure 3 if MW18 is substituted for MW17 as an upgradient well (see Comment No. 24). Update Table 7 to reflect additional monitoring wells to be sampled per Comment No. 23.**

The table has been modified. Please see responses to comments #23 and #24.

37. **Table 8. Update Table 8 to reflect additional monitoring wells to be sampled per Comment No. 23.**

The table has been modified to reflect the additional locations identified in the response to comment #23.

38. **Table 9. Insert the footnote describing OBJ #5.**

The table has been revised accordingly.

39. **Table 11. Update Table 11 to include the sampling frequency in Comment No. 26. Correct spelling of *Target* in footnote.**

The table has been revised accordingly. Please see response to comment #26.

40. **Table 12. Correct Table 12 to reflect the current baseline values for all chemicals to be monitored in the RLTGMP, as recommended in Comments No. 20 and 28.**

The table has been revised to reflect the current baseline values. Please see responses to comments #20 and #28.

41. **Appendix B - FSP, Page 1. The QAPP determines the standards for the field data collection procedures and record keeping procedures and is referenced in the FSP. However, the elements of the QAPP that have been included in the FSP and Groundwater Monitoring SOP, are not always consistent or complete. For example, the FSP outlines four QC samples to be collected during sampling activities, however it does not include the temperature blanks as described in the QAPP.**

We were not able to locate specific inconsistencies between the QAPP and FSP, but would be able to reply more definitively if the agency can provide more specifics. Regarding temperature blanks, they are not *collected* by the field crew, but are supplied by the laboratory and used only for determination of temperature when the cooler is received. The FSP only addresses QC samples that are collected by the field crew. A sentence has been added to the FSP to state that the field crew will make sure the appropriate number of temperature blanks are included in the sample shipments.

42. **Appendix B - FSP, Page 2, 2nd and 3rd sentences. Revise 2nd sentence to include reference to Table 11 in the Plan for locations and frequency for residential well sampling. Revise 3rd sentence to indicate that Figures 1 and 2 show the water level monitoring network and Figures 3 and 4 show the sampling well network in the upper and lower aquifers, respectively.**

The text has been revised as recommended.

43. **Appendix B - FSP, Pages 3, 5, and 9. Correct *MW* to *MWH*.**

The text has been revised as recommended.

44. **Appendix B - FSP, Page 5, Section 4.6. "Solid IDW, such as soil cuttings generated during drilling activities, will be dumped into the fire pond on the ACS Site." The fire pond has been filled with PCB-impacted soils from the wetland area and will be improved with an ISVE system. A different disposal option should be provided for solid IDW. In addition, EPA guidance documents should be consulted for the appropriate disposal of stained PPE that may not be disposable in a local landfill.**

The text has been revised to indicate that prior to the completion of the final cap, all IDW will be disposed within future ISVE areas. After the final cap is complete, MWH will arrange for proper off-site disposal of any IDW. Text has also been added to indicate that grossly contaminated PPE will be treated as solid IDW.

45. **Appendix B - FSP, Page 7, Section 6.1. There is no mention of the time required for the equilibration of water level in the wells after removal of the well caps before determining the water level.**

Due to the relatively high permeability of the sandy soils at the site, water levels equilibrate rapidly. The following text has been added: "The measurement will be repeated after approximately 30 seconds to assure that water levels have equilibrated and that the first measurement was accurate. If water levels differ by more than 0.01 feet, then successive water levels readings will occur until water levels are consistent over a 30 second period."

46. **Appendix B - FSP, Appendix A - SOP, Groundwater Sampling, Page 1. The Scope section references *private* wells. This reference should probably be [changed] to *residential* wells.**

All instances of "private" have been changed to "residential."

47. **Appendix B - FSP, Appendix A - SOP, Groundwater Sampling, Page 2, Section II, Low Flow Sampling at Monitoring Wells. This section does not address the dedicated tubing needs, requirements for replacement, or inspection and maintenance of the tubing.**

The text has been added describing the tubing requirements.

48. **Appendix B - FSP, Appendix A - SOP Groundwater Sampling, Page 2, Section II, Low Flow Sampling at Monitoring Wells. This SOP does not include procedures if the well is pumped dry during sampling.**

Although "pumping dry" has not been a common occurrence at the ACS Site, the following text has been added describing the procedures to follow if a well is dry or pumped dry:

> *"If the water column in a well is less than three feet, then the well will be labeled "dry" and will not be sampled. A water column of at least three feet is required to collect a representative and accurate groundwater sample. The intake of the Grundfos sampling pump is at the top of the pump. During operation, the Grundfos pump cools itself by contact with the surrounding water. Without the cooling effect of the water, the pump will overheat and fail to operate properly, and also cause the groundwater temperature to increase, which may alter the sample composition by driving off VOCs. Because drawdown of up to one foot is expected during sampling, at least two feet of water is required above the intake of the pump. Since the pump length is about 1 foot, the pump intake will be located at least one foot above the bottom of the well. These requirements are the basis for minimum three feet of water in a well.*
>
> *If the water level does not stabilize during purging, and the well is pumped dry, then the purging activities will cease at this well. The well will then be immediately sampled once the water level has returned to its original level, or within 24 hours, whichever is sooner."*

49. **Appendix B - FSP, Appendix A - SOP, Groundwater Sampling, Page 2, Section II, Low Flow Sampling at Monitoring Wells, Paragraph C. The procedure using a VOA vial is not recommended because the 40ml vial used to confirm flow rate may be used as an actual sample vial, making laboratory results non-usable.**

Given the low flow of sampling, and the small size of the vials, we believe it is reasonable to use them for the volumetric measurement purpose. However to minimize the potential that a measurement vial will subsequently be used for sample collection, we have added several precautionary measures to the FSP. Specifically, the measurement vial will be kept away from the vials used for sampling, and its cap thrown away. Please note that the vials used for sampling arrive from the laboratory with a custody seal; any vial without an intact custody seal is not used for sampling. Text has been added to the FSP to clarify these points.

50. **Appendix B - FSP, Appendix A - SOP, Groundwater Sampling, Page 2, Section II, Low Flow Sampling at Monitoring Wells, Paragraph C. Well purging rate of 0.5 L/min may be high. Verify with EPA guidance documents.**

    The USEPA document referenced in the SOP, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, (EPA/540/S-95/504), states that flow rates of 0.1 to 0.5 L/min can be used for low-flow sampling. Most importantly, little to no stress should be placed on the aquifer, and this can be measured by the amount of drawdown in the well.

51. **Appendix B - FSP, Appendix A - SOP, Groundwater Sampling, Page 3, Section II, Low Flow Sampling at Monitoring Wells, Paragraph F. Please refer to EPA guidance document for stabilization (e.g., EPA specifies 10 NTU for turbidity, not 10%).**

    The USEPA document referenced in the SOP, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, (EPA/540/S-95/504), states that 10% is adequate for turbidity stabilization.

52. **Appendix B - FSP, Appendix A - SOP, Groundwater Sampling, Page 3, Section II, Low Flow Sampling at Monitoring Wells, Paragraph H. BVSPC recommends that all purge water from all monitoring wells be containerized and transported to the MWH treatment building where it will be treated and discharged.**

    The recommendation has been incorporated into the FSP.

53. **Appendix B - FSP, Appendix A - SOP, Groundwater Sampling, Page 3, Section II, Low Flow Sampling at Monitoring Wells, Paragraph I. Please indicate how often the decontamination water will be changed.**

    Text has been added stating that decontamination water will be changed every day.

54. **Appendix B - FSP, Appendix A - SOP, Groundwater Sampling, Page 3, Section III, Low Flow Sampling at Private Wells. There are inconsistencies between the SOPs for the low-flow sampling at monitoring wells (Section II) and private wells (Section III). For example, the sample collection order is not described for the sampling activities at the monitoring wells, but it is presented for the private wells. In addition, the sample collection order for the private wells is inconsistent with the order presented in the QAPP. In addition, there are many references to *private* wells, but the RLTGMP identifies these as *residential* well.**

No sampling order was specified in the monitoring well SOP because only VOCs were to be collected. However, based on the November 29 meeting, the monitoring well SOP has been updated to include sample collection order for the additional parameters added to the monitoring plan. Finally, the QAPP states that, "The procedures for sample collection order in the project-specific FSP or Work Plan will be followed."

55. **Appendix B - FSP, Appendix A - SOP, Groundwater Sampling, Page 3, Section III, Low Flow Sampling at Private Wells. Update SOP to address the future sampling of PW-A at 1007 Reder Road inasmuch as electricity was not available to operate the pump during the October sampling event.**

The purpose of this SOP is to state sampling procedures. It does not list the specific wells that are to be sampled. In fact, as stated in the Interim Monitoring Plan, the requirement for residential well sampling simply states that up to 5 residential wells will be sampled annually. It was U.S. EPA's objective to leave the specific wells undefined so that the locations could be easily changed if the conditions warranted sampling different wells in a given year.

56. **Appendix B - FSP, Appendix A - SOP, Groundwater Sampling, Page 5, Section V, Sample Collection and Preparation, Paragraph B.3. Please check the EPA protocol on sampling for volatiles. The method described may wash out essential preservatives.**

The SOP mentions specifically that the vial will be filled carefully. Text has been added to specify that care will be taken to assure that no preservative will be washed out.

57. **Appendix B - FSP, Appendix A - SOP, Monitoring Well Installation, Page 1. Please indicate appropriate ASTM methods.**

The appropriate ASTM methods have been added to the SOP.

58. **Appendix B - FSP, Appendix A - SOP, Monitoring Well Installation, Page 1, Section I, Installation of Monitoring Well, Paragraph A.3. Please include procedures if the confining layer is bedrock.**

It is not anticipated that any drilling will be completed to bedrock. If in the future, drilling into bedrock is required, a separate SOP will be submitted for approval.

59. **Appendix C, Site Safety Plan Addendum, Page 1, Section 1.0, 2nd paragraph, last sentence. Modify sentence to read: ". . .possibly monitoring well, *piezometer and staff gauge* abandonment or installation."**

The text has been revised as recommended.

60. **Appendix C, Site Safety Plan Addendum, Page 2, Section 2.2, 3rd bullet. Modify sentence to read: ". . .monitoring wells, piezometers, *or staff gages.*"**

The text has been revised as recommended.

61. **Appendix C, Site Safety Plan Addendum, Page 14, Section 4.8, Investigative Derived Waste. Revise section to respond to Comment No. 44.**

The text has been revised as recommended.

RESPONSE TO IDEM COMMENTS

62. **Page 11, Section 3.2.1, Water Level Measurements: This section discusses monitoring wells and piezometers to be included and excluded from future groundwater gauging events. It is noted that for the upper aquifer essentially all gauging points located to the southwest of the site (in the area of the Griffith Landfill) have been excluded. In the proposed Long-Term Groundwater Monitoring Plan (Figure 1), approximately 2000 feet separates monitoring well MW-14, located west of the site, and monitoring well MW-15, located south-southwest of the site. It is recommended that some gauging points be retained in the Griffith Landfill area so that a sufficient distribution of gauging points remain to allow for determination of groundwater flow patterns in all areas surrounding the site. Monitoring well MW-4S and piezometers P13 and P17 appear to be well positioned to fill in data gaps that exist between monitoring wells MW-14 and MW-15 on Figure 1.**

    Please see response to Comment #17.

63. **In the lower aquifer, relatively few gauging points exist to the south and southwest of the site. The contractor proposes to exclude monitoring well M4D from future gauging events. This monitoring well is one of the few gauging points located southwest of the site, and if excluded, leaves a distance of approximately 1625 feet separating monitoring wells MW-09R and MW-50. It is recommended that monitoring well M4D be retained in the lower aquifer gauging network.**

    Please see response to Comment #17.

64. **Page 11, Section 3.2.2, Sampling Parameters: This section proposes reducing the number of analytes to ten volatile organic compounds (VOCs). The semi-volatile organic compounds (SVOCs) bis(2-chloroethyl)ether was detected in 27% of the upper aquifer samples, and in 8.6% of the lower aquifer samples. The contractor states that "It is unlikely that bis(2-chloroethyl)ether will be detected at downgradient monitoring wells without the prior detection of benzene and chloroethane due to the higher mobility of the VOCs." Because bis(2-chloroethyl)ether was commonly detected, it is recommended that groundwater samples be analyzed for bis(2-chloroethyl)ether annually.**

    Based on the November 29 meeting, MWH has evaluated the detections of bis(2-chloroethyl)ether. Consistent elevated detections of this compound are found at monitoring wells MW06, MW19, and MW09R. It has also been detected historically at MW14, MW46, MW48, MW49 and MW45; however recent detections of this compound at these wells have been below 3 µg/L. Therefore, we propose to add analysis of bis(2-chloroethyl)ether annually at MW06, MW19, and MW09R.

65. **Page 12, Section 3.2.2, Sampling Frequency: It is noted that two successive sections in the document are numbered 3.2.2.**

    The numbering has been revised to eliminate redundancy.

66. **Page 12, Section 3.2.2, Sampling Frequency: This section proposes to reduce the number of sampling events from quarterly to once every nine months. By using this schedule, groundwater samples will be collected during each of the three seasons once every three years. This is unacceptable. A better sampling program would employ semi-annual sampling, with samples collected each spring when groundwater levels are at their maximum, and each fall**

when groundwater levels are at a minimum.

See response to Comment #22.

67. **Page 12, Section 3.2.3, Upper Aquifer Monitoring Locations: The contractor states, "Interior well MW13 is not included since groundwater sample analyses from this well have not indicated the presence of site-related contaminants for the past three years." According to the potentiometric surface map presented as Figure 1 in the Technical Memorandum, March 2001 Groundwater Monitoring Report, prepared by the contractor and dated June 2001, monitoring well MW-13 is the closest monitoring well that is roughly downgradient from monitoring well MW-48. The proposed upper aquifer monitoring locations, depicted on Figure 3, show no monitoring locations downgradient from MW-48 or MW-49, the two most impacted monitoring wells in the upper aquifer. Additional sampling points are needed in the northern part of the upper aquifer. It is recommended that MW-13 and MW-37 be added to account for downgradient measurement. Additionally, there are no upper aquifer monitoring locations between MW-14 and MW-06. Including M-4S will provide needed monitoring information to understand side gradient flow patterns and contaminant levels for the southwest portion of the site.**

    Please see response to comment #23.

68. **Page 12, Section 3.2.3, Upper Aquifer Monitoring Locations: The contractor states that monitoring well MW-18 is obstructed. If the well cannot be used, it must be properly abandoned according to Indiana Rule 312 IAC 13-10-2, as referenced in Appendix B (Section 4.4).**

    MW18 would be abandoned in accordance with applicable regulations upon approval of Plan. Well MW17 has been proposed as the replacement upgradient well.

69. **Page 14, Section 3.3.2, Analytical Results: Table 10 provides a listing of the new baseline concentrations for each monitoring well. It is assumed that the contractor is actually referring to Table 12.**

    The text was in error and it has been corrected.

70. **The contractor subsequently states that the new baseline for data comparison will be the highest concentration detected for any constituent in each monitoring well, and that if a sample result exceeds the baseline concentration by 25%, the well will be resampled. If the contaminant concentration exceeds the baseline by 50% or 20 μg/L, whichever is higher, the monitoring well will be resampled for the full list of analytes. This is unacceptable. Setting the baseline standard at the highest contaminant level ever recorded for a given constituent and well, and then requiring that this standard be exceeded by 25% to 50% before the well will be resampled is not adequate. The likelihood of these wells ever having to be resampled is slim. To assure there is no further contaminant migration into the aquifers, IDEM staff would prefer to see a schedule in place that would sample all the wells for the full analyte scan every two years or bi-annually.**

    Please see the response to comments #20 and #28.

71. **Page 14, Section 3.3.3, Monitoring Point Replacement: Damaged or unused monitoring wells or piezometers must be properly abandoned according to Indiana Rule 312 IAC 13-10-2, as referenced in Appendix B (Section 4.4).**

Upon approval of the Plan, a proposal will be submitted to accomplish any necessary well construction, repair, or abandonment. All such actions would be completed in accordance with the applicable regulations.

72. **Table 3, Summary of Historical Groundwater Monitoring Results – Upper Aquifer: There is no data for MW-17. This well is purposed for upper aquifer groundwater monitoring, yet there is no historical information regarding this well. Please include MW-17 in Table 3.**

Please see the response to comment #33.

If you have any further comments or questions, please do not hesitate to call me at (630) 836-8923.

Sincerely,

MONTGOMERY WATSON HARZA

Peter Vagt, Ph.D., CPG
Vice President

cc: Sean Grady, IDEM
Barbara Magel
ACS RD/RA Technical Committee

Attachments: A – Cross-sections A-A', B-B', and C-C'
B – VOC distribution figures
C – Tables 8 & 10

CAS/PJV/emp
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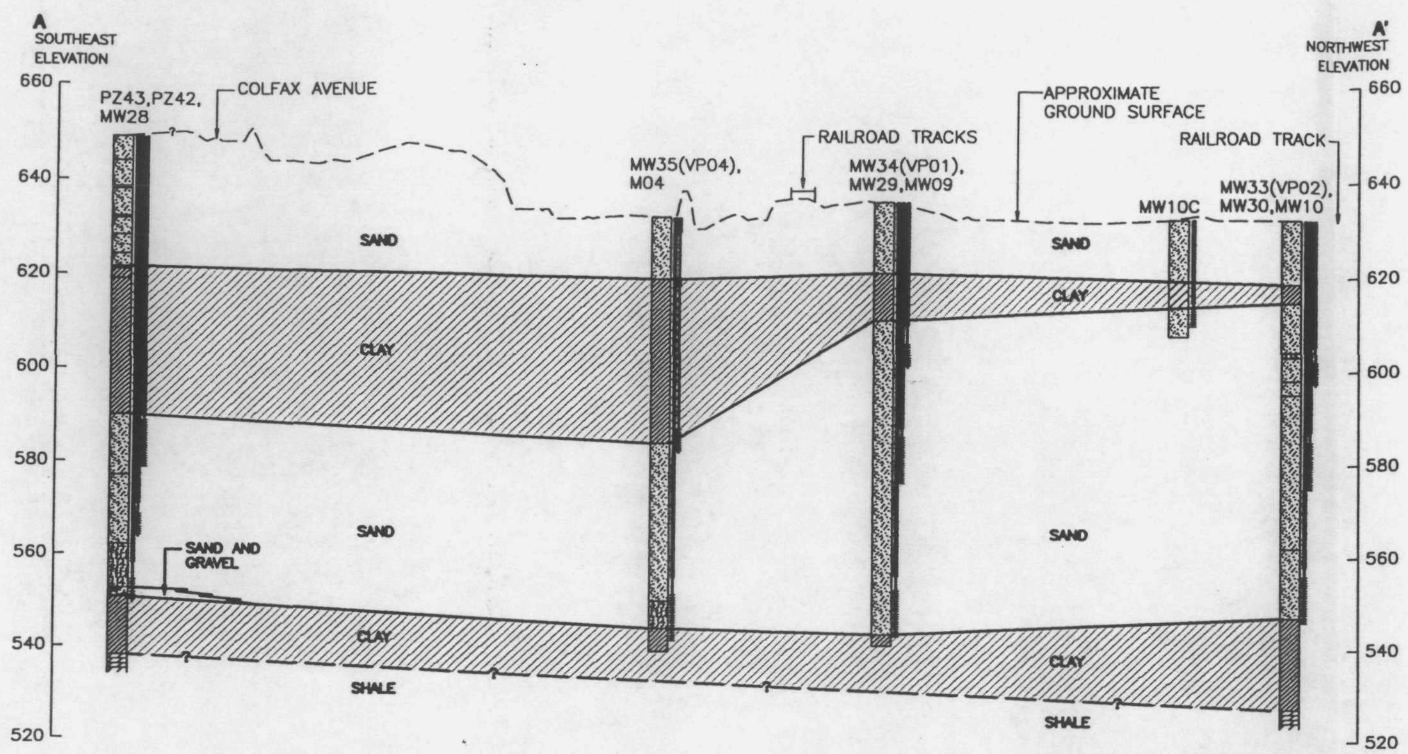
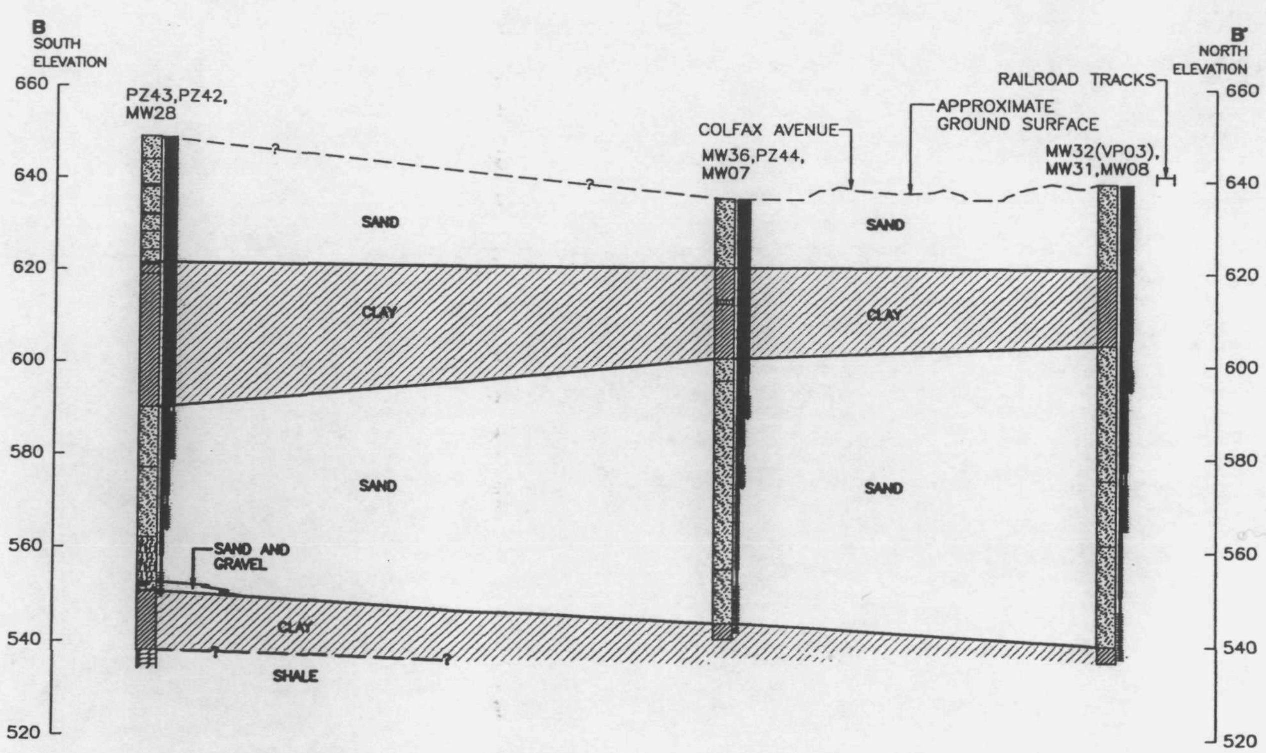
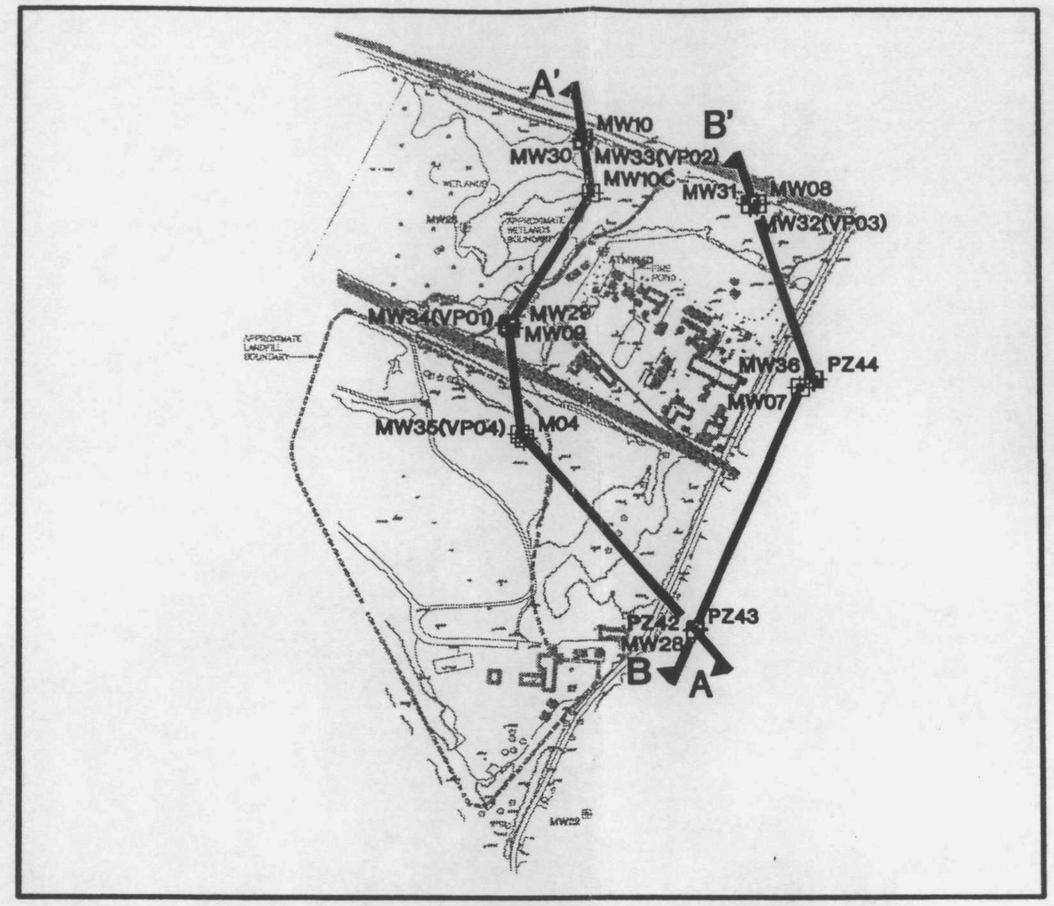
A





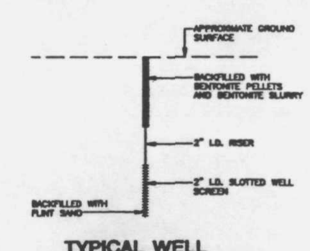


CROSS-SECTION LOCATION MAP

north

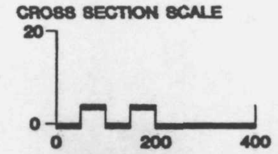
LEGEND

- SAND WITH LOW SILT AND CLAY CONTENT (SP)
- SILTY SAND (SM)
- SAND AND GRAVEL WITH LOW SILT AND CLAY CONTENT (SP/GP)
- SILT (ML)
- LEAN CLAY (CL)
- SHALE



TYPICAL WELL INSTALLATION DETAIL
NOT TO SCALE

CROSS SECTION SCALE



SCALE IN FEET
VERTICAL EXAGGERATION: TEN TIMES

NOTES

1. THE STRATUM LINES ARE BASED ON INTERPOLATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS.
2. REFER TO FIGURE 1 FOR ADDITIONAL NOTES.
3. CROSS SECTION LOCATIONS ARE SHOWN ON FIGURE 2.
4. FOR THE PURPOSE OF ILLUSTRATING SUBSOIL CONDITIONS ON THE CROSS SECTIONS, SOME OF THE BORING LOGS HAVE BEEN SIMPLIFIED. FOR A DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS AT INDIVIDUAL BORINGS, REFER TO SOIL BORING LOGS, APPENDIX A OF TEXT.
5. FOR COMPLETE MONITORING WELL INSTALLATION DETAILS REFER TO APPENDIX C OF TEXT.
6. HORIZONTAL DISTANCES ARE MEASURED WITH RESPECT TO THE CENTER OF EACH SOIL BORING LOCATION.
7. EXISTING GROUND SURFACE WAS TAKEN FROM FIGURE 1.
8. ELEVATIONS ARE SHOWN IN REFERENCE TO U.S.G.S. DATUM.
9. QUESTION MARKS AT THE CONTACTS BETWEEN SUBSOIL TYPES INDICATES THE CONTACTS ARE INFERRED.
10. WELL M04 INFORMATION OBTAINED FROM ATC BLATTERT, INC., INDIANAPOLIS, INDIANA, FOR CITY OF GRIFFITH, INDIANA.

FOR PRESENTATION TO EPA ON JUNE 12, 1996.

FIGURE 8

Developed By	DAP
Drawn By	CCM
Approved By	
Date	
Reference	
Revisions	

NORTH-SOUTH CROSS SECTION

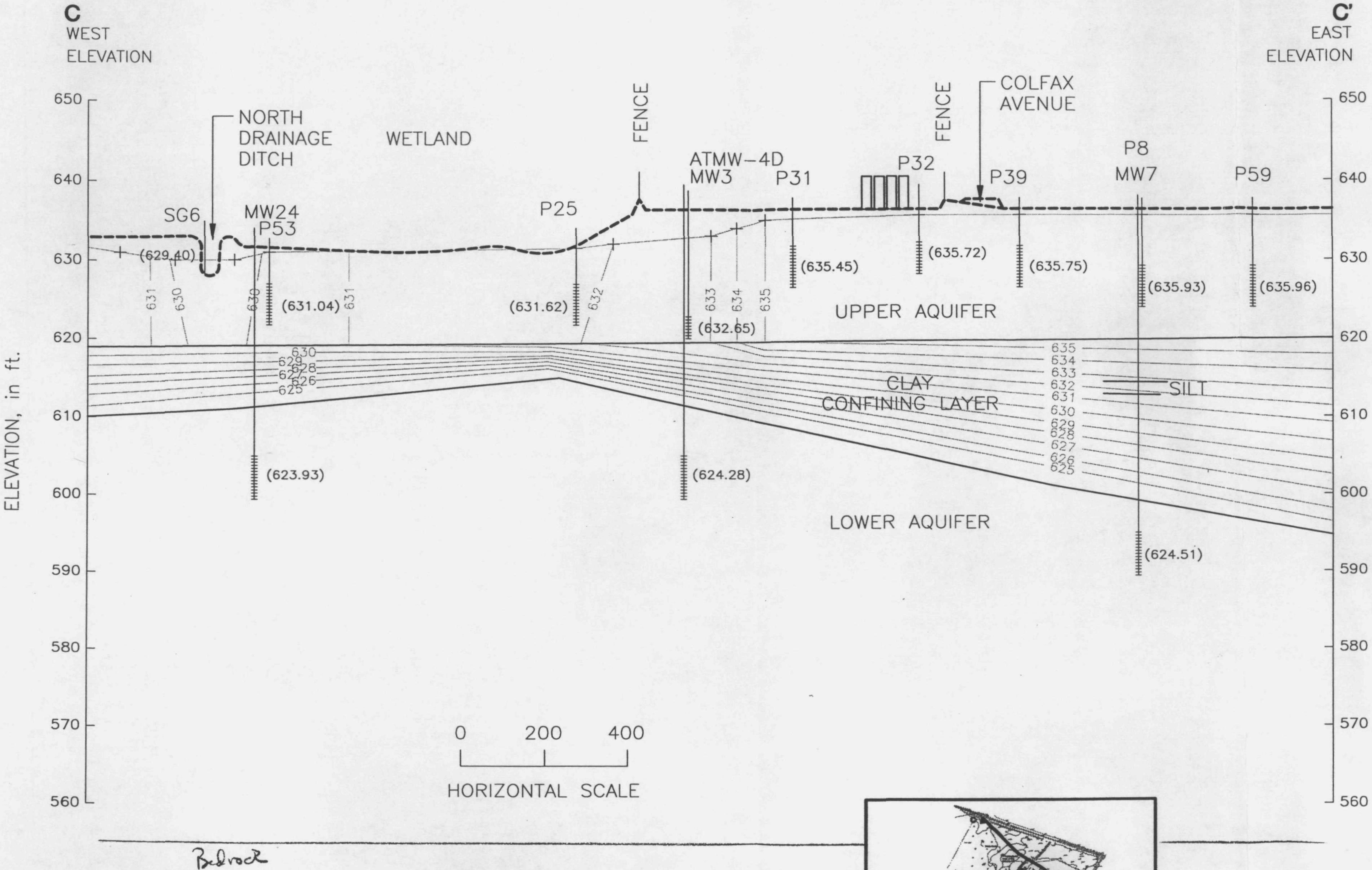
AMERICAL CHEMICAL SERVICE
NPL SITE
GRIFFITH, INDIANA

Drawing Number
4077.0072**B16**

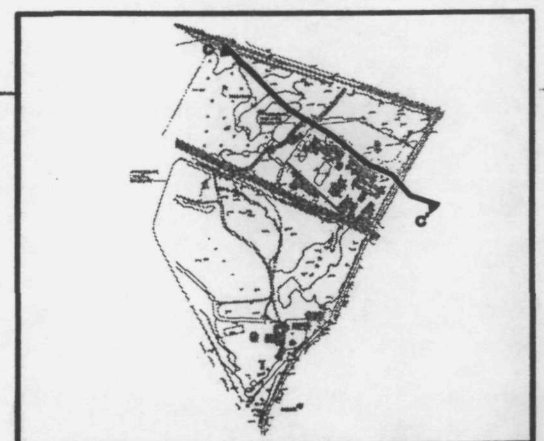
MONTGOMERY WATSON

QUALITY CONTROL		
Graphic Standards CCM	6-5-96	Technical Review
Lead Professional		Project Manager
Management Review		Other

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.



FOR PRESENTATION TO EPA ON JUNE 12, 1996.



CROSS-SECTION LOCATION MAP

north

FIGURE 10

EAST-WEST CROSS SECTION WITH WATER LEVELS

AMERICAL CHEMICAL SERVICE NPL SITE GRIFFITH, INDIANA

Developed By DAP
Drawn By CCM
Approved By
Date
Reference
Revisions

Drawing Number
4077.0072B19

MONTGOMERY WATSON

QUALITY CONTROL
Graphic Standards
Lead Professional
6-5-96
Technical Review
Project Manager
Management Review
Other

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B

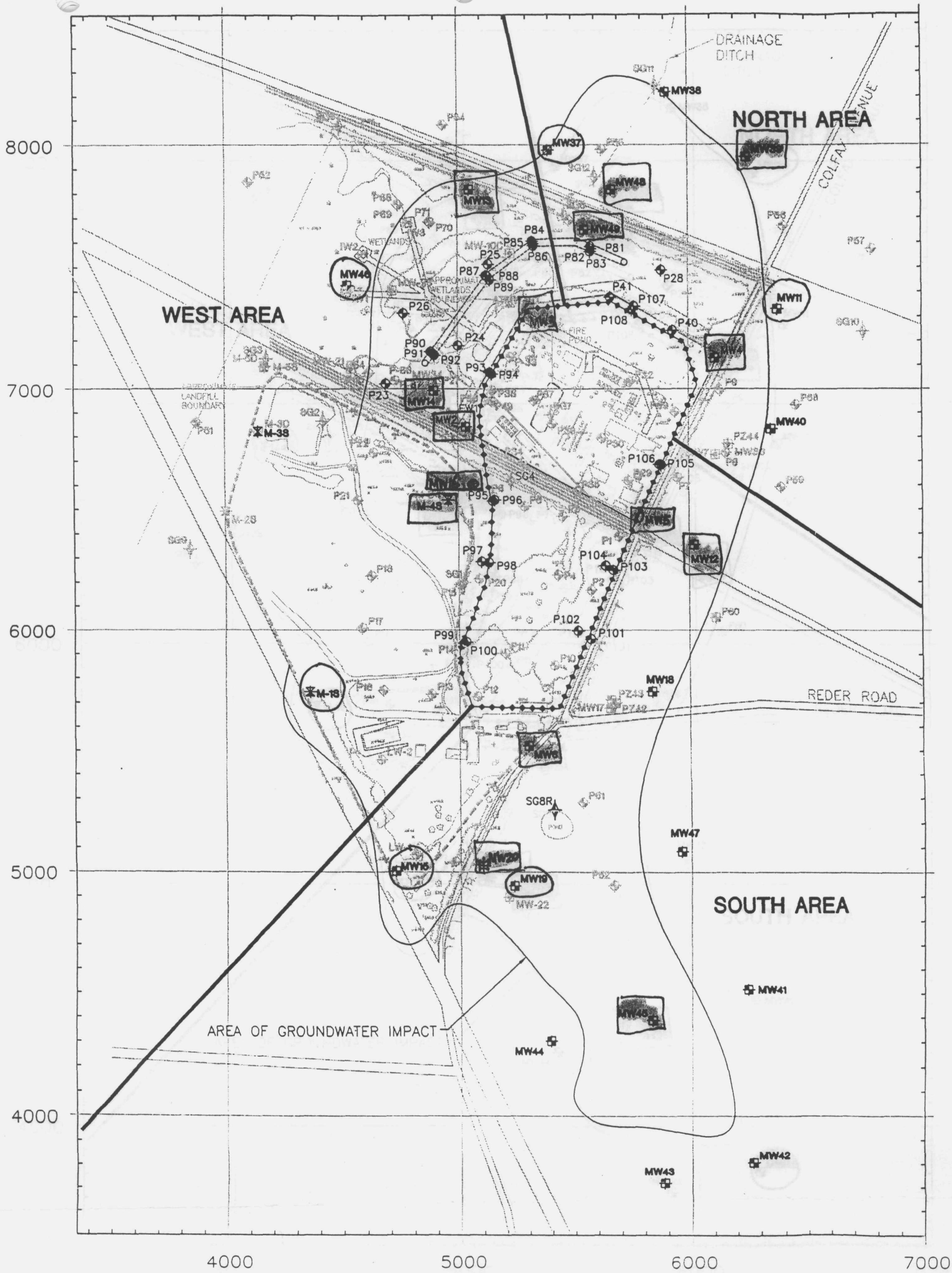


Figure B.1 - Locations of Benzene Detections in the Upper Aquifer
□ - Concentration above 10 μg/L
○ - Concentration below 10 μg/L

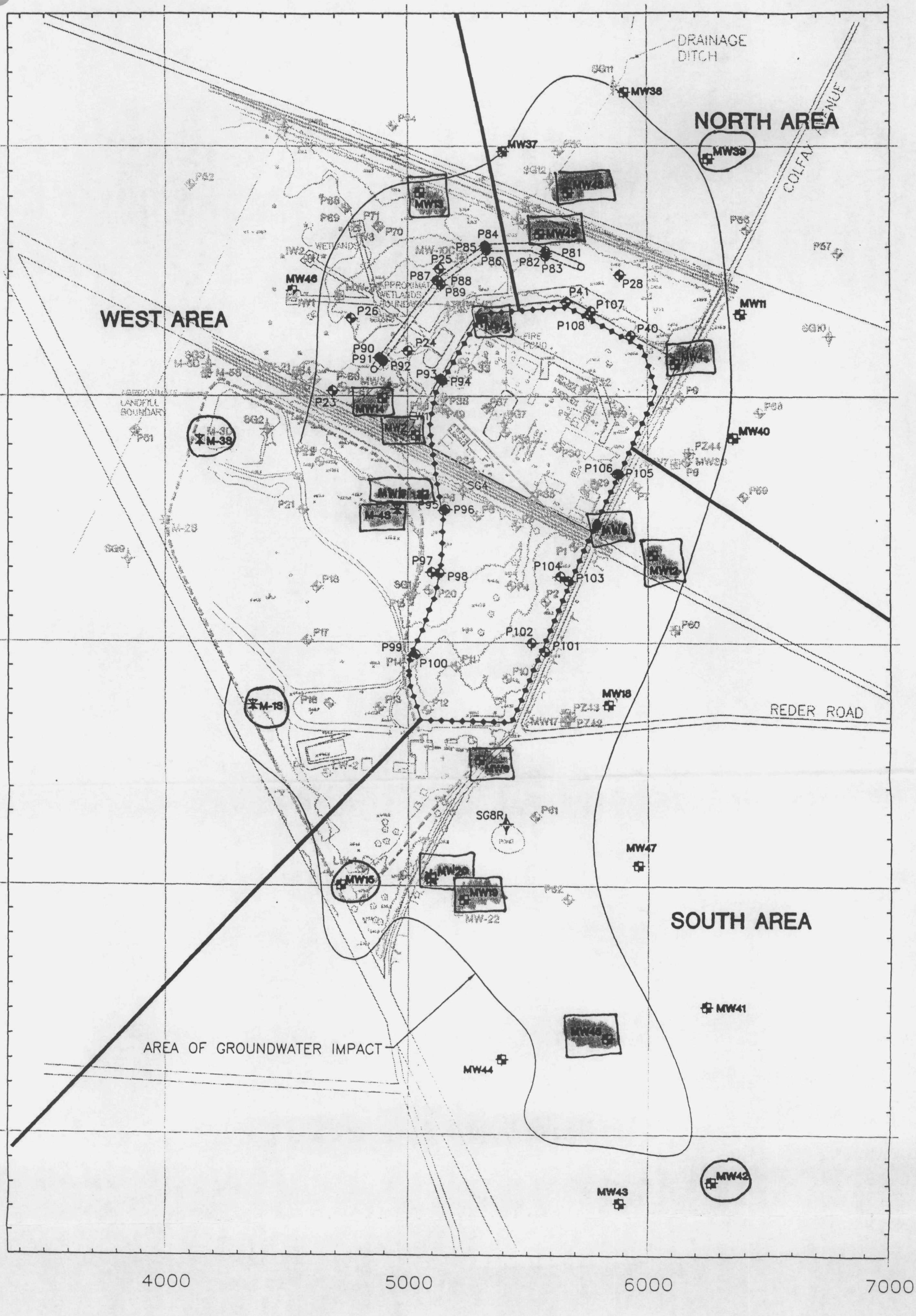
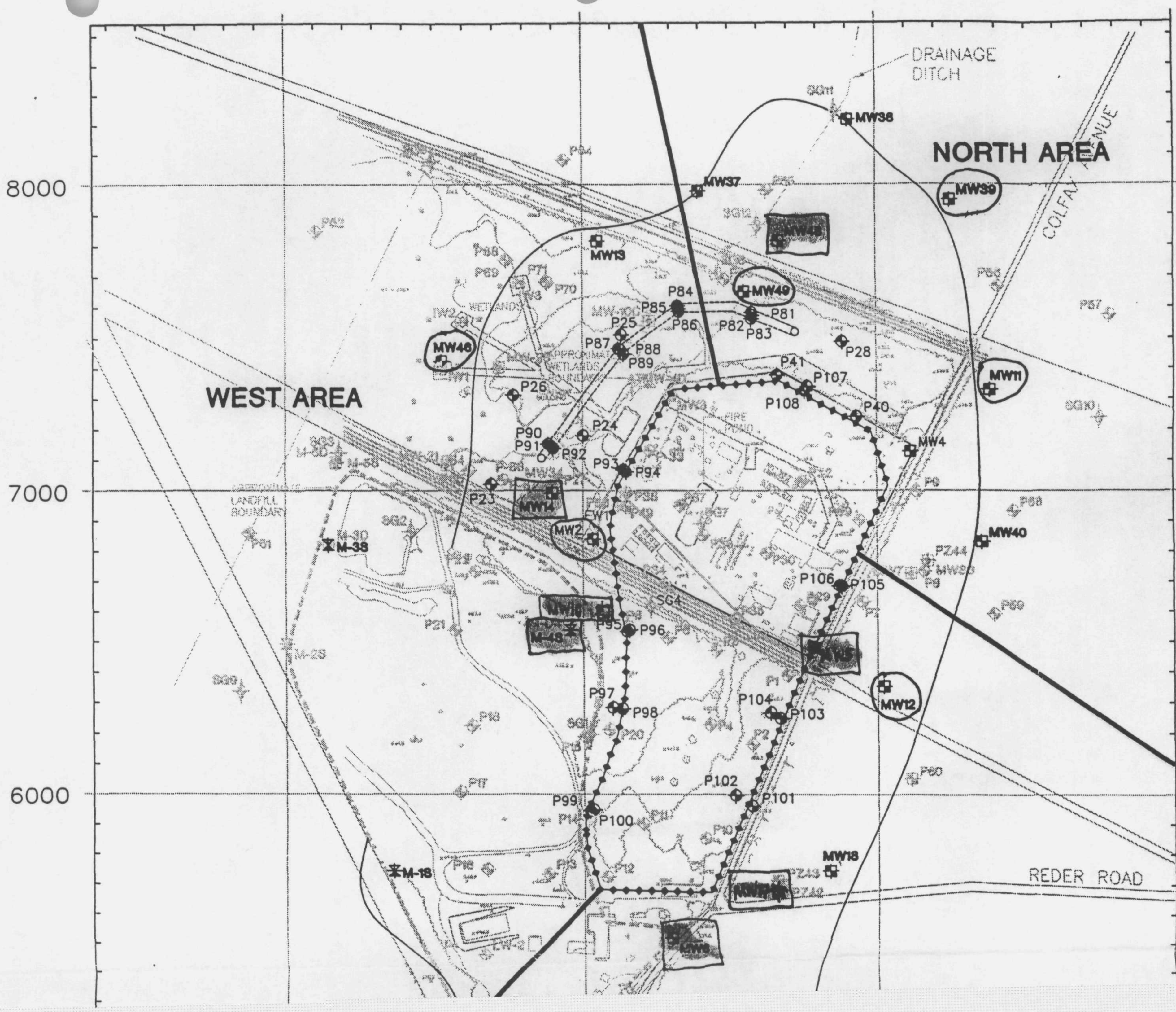


Figure B.2 - Locations of Chloroethane Detections in the Upper Aquifer

□ - Concentration above 10 μg/L

○ - Concentration below 10 μg/L



DRAINAGE DITCH
NORTH AREA
WEST AREA
COLFAX AVENUE
REDER ROAD
8000
7000
6000
MW36
MW37
MW39
MW13
MW49
MW46
MW11
MW4
MW14
MW2
MW40
MW12
MW18
P84
P85
P86
P81
P82
P83
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M-1S

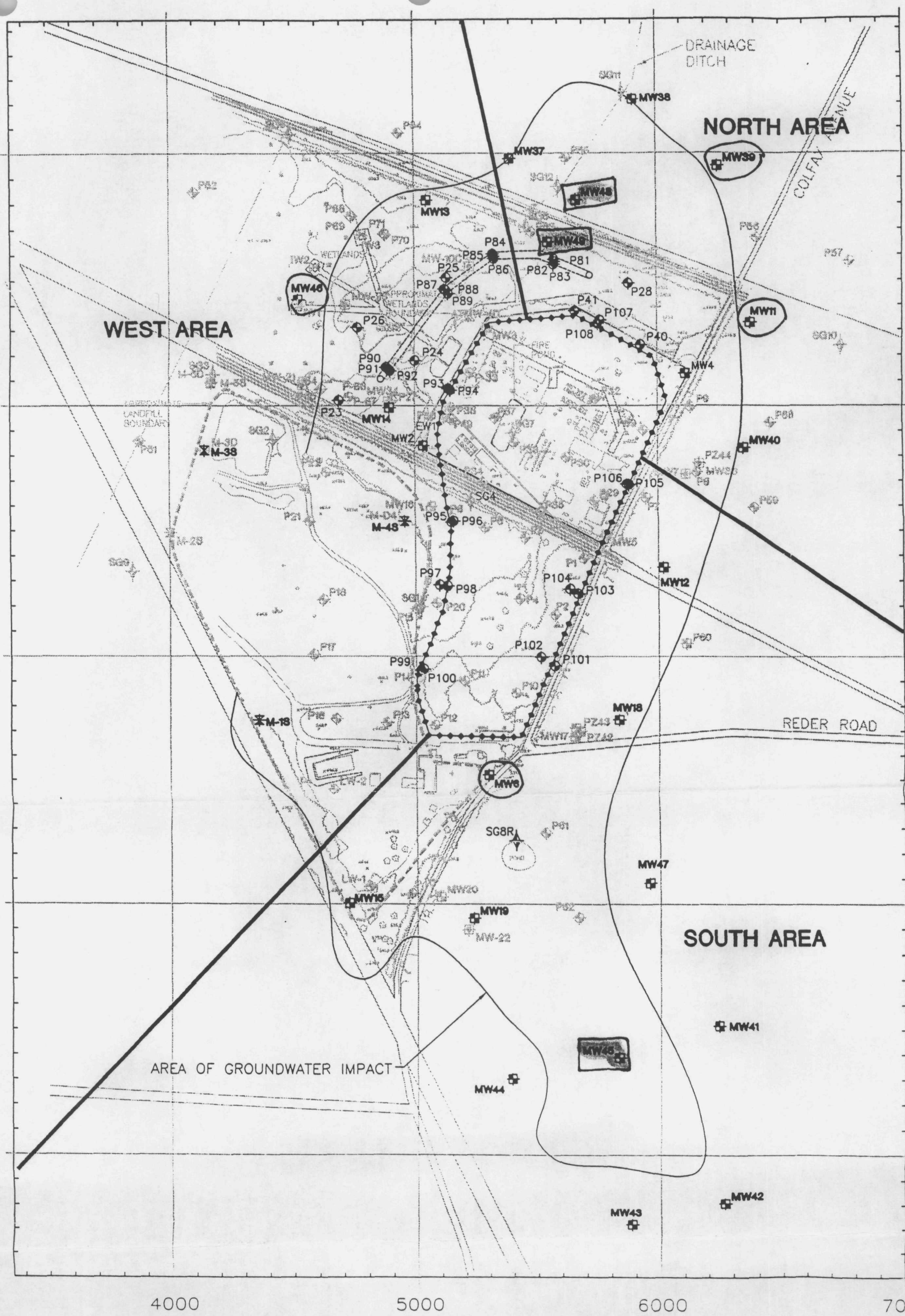

Figure B.4 - Locations of 1,2-Dichloroethane Detections in the Upper Aquifer

□ - Concentration above 10 μg/L

○ - Concentration below 10 μg/L

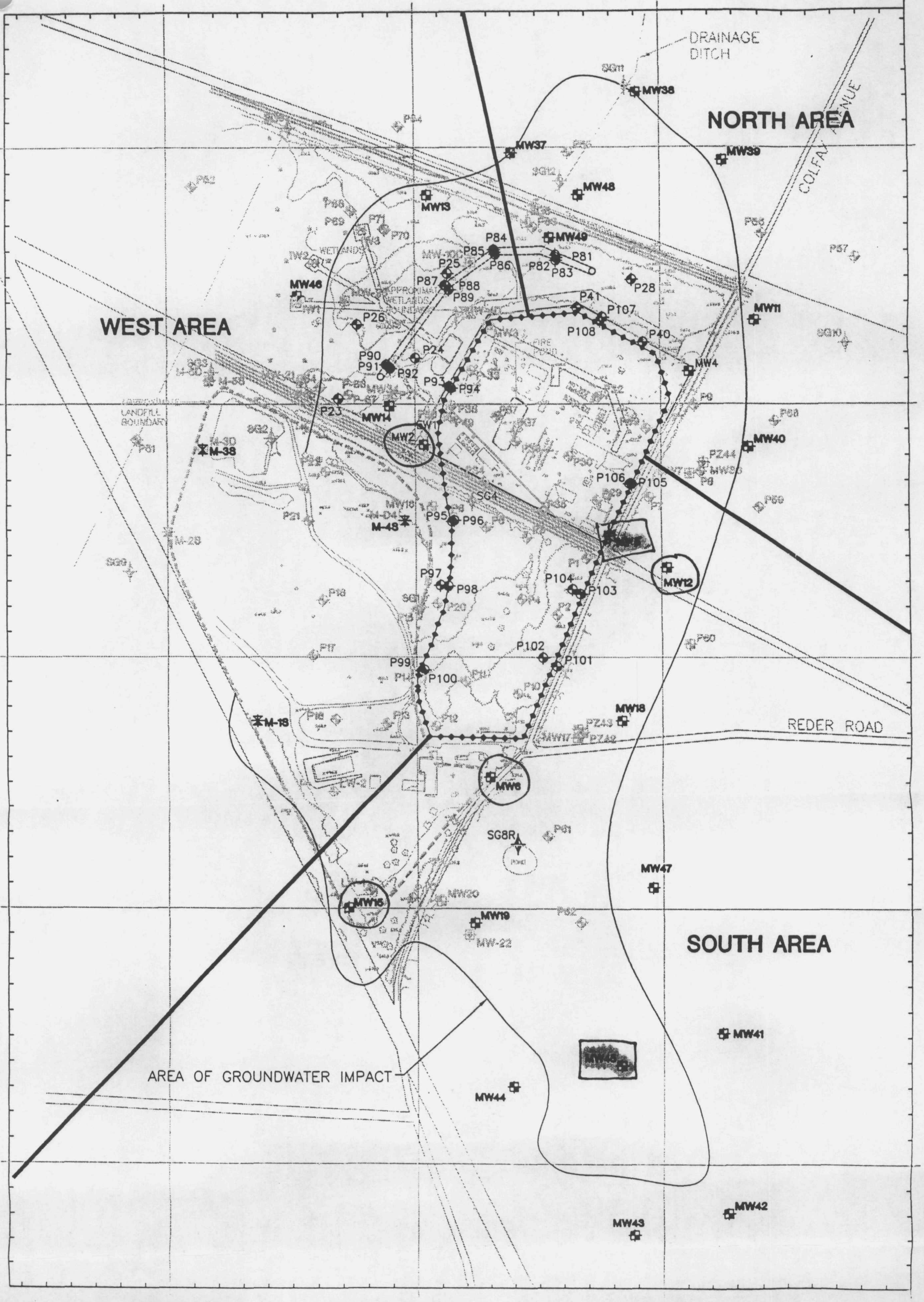

Figure B.5 - Locations of Chlorobenzene Detections in the Upper Aquifer

□ - Concentration above 10 μg/L

○ - Concentration below 10 μg/L

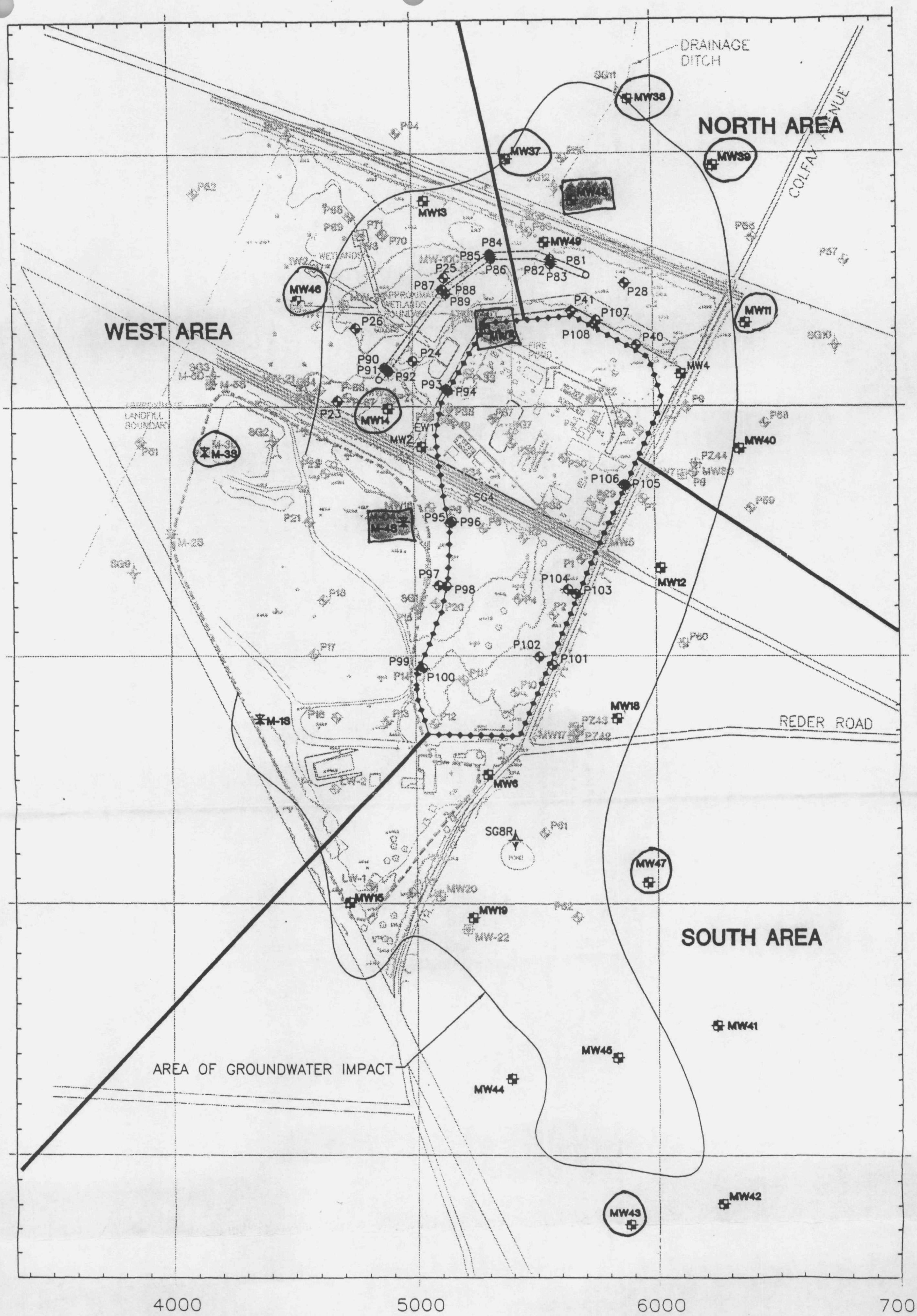

Figure B.6 - Locations of Chloromethane Detections in the Upper Aquifer

□ - Concentration above 10 μg/L

O - Concentration below 10 μg/L

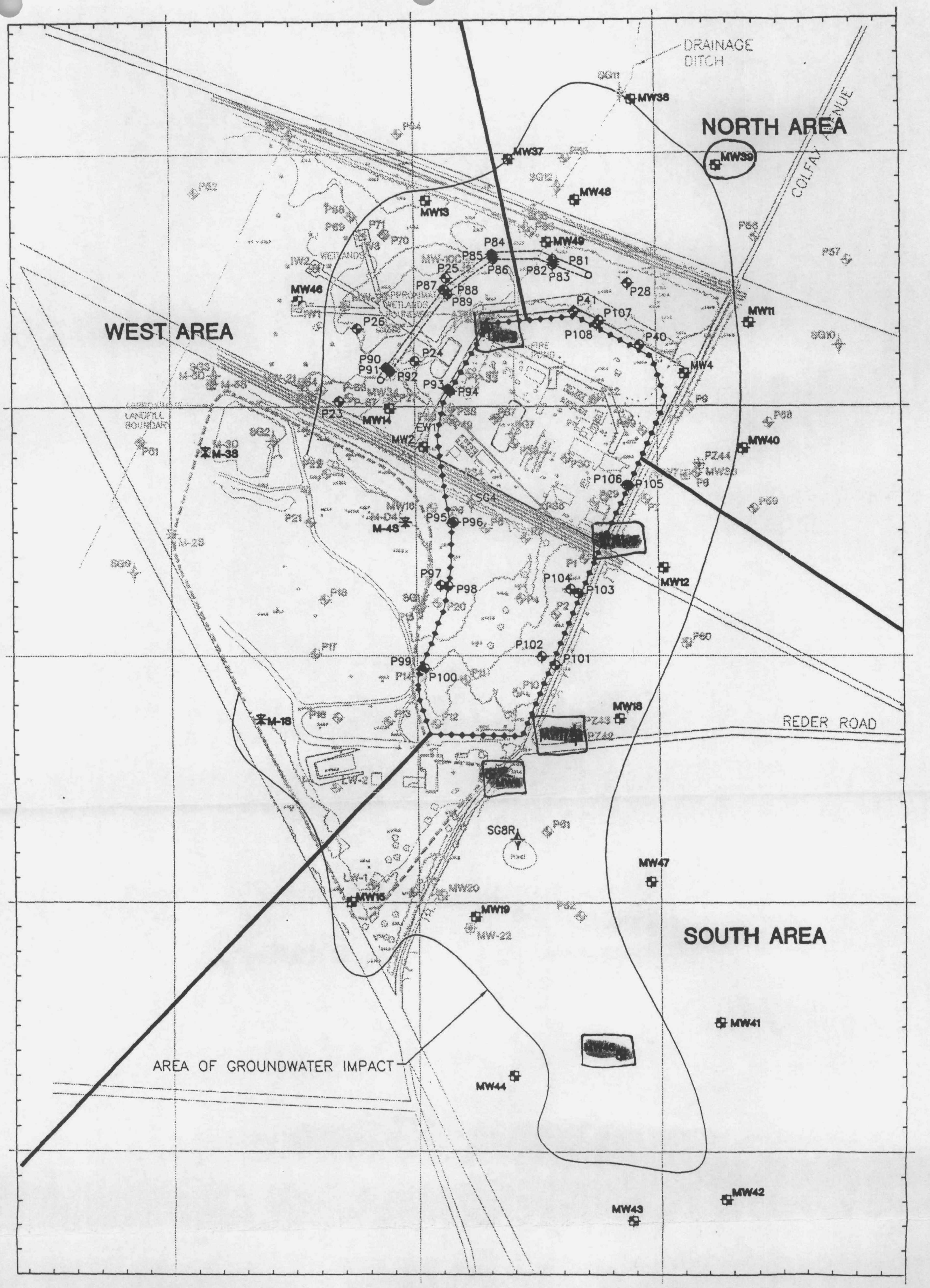

Figure B.7 - Locations of Ethylbenzene Detections in the Upper Aquifer
□ - Concentration above 10 μg/L
○ - Concentration below 10 μg/L

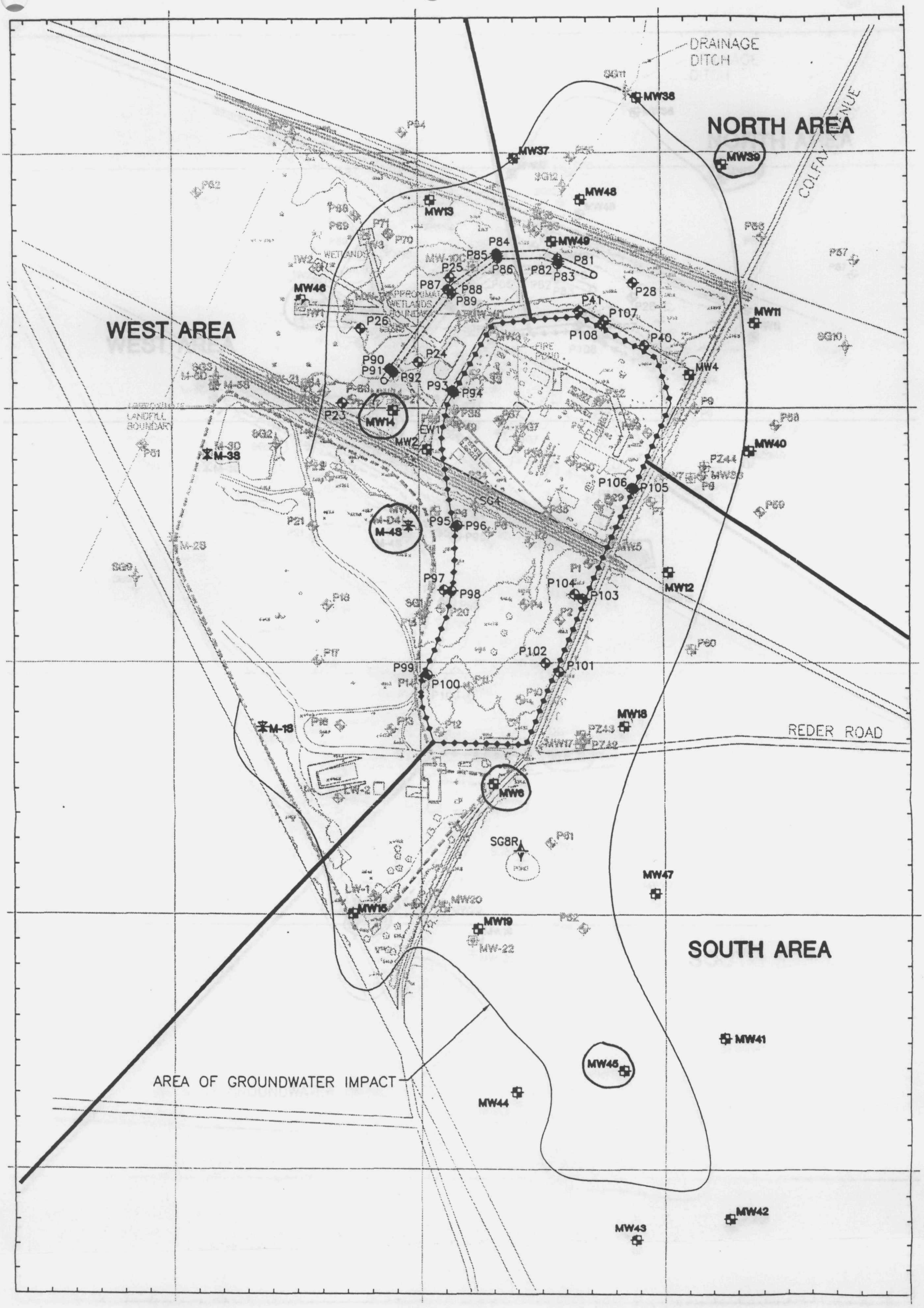

Figure B.8 - Locations of Trans-1,2-Dichloroethene Detections in the Upper Aquifer

□ - Concentration above 10 µg/L

○ - Concentration below 10 µg/L

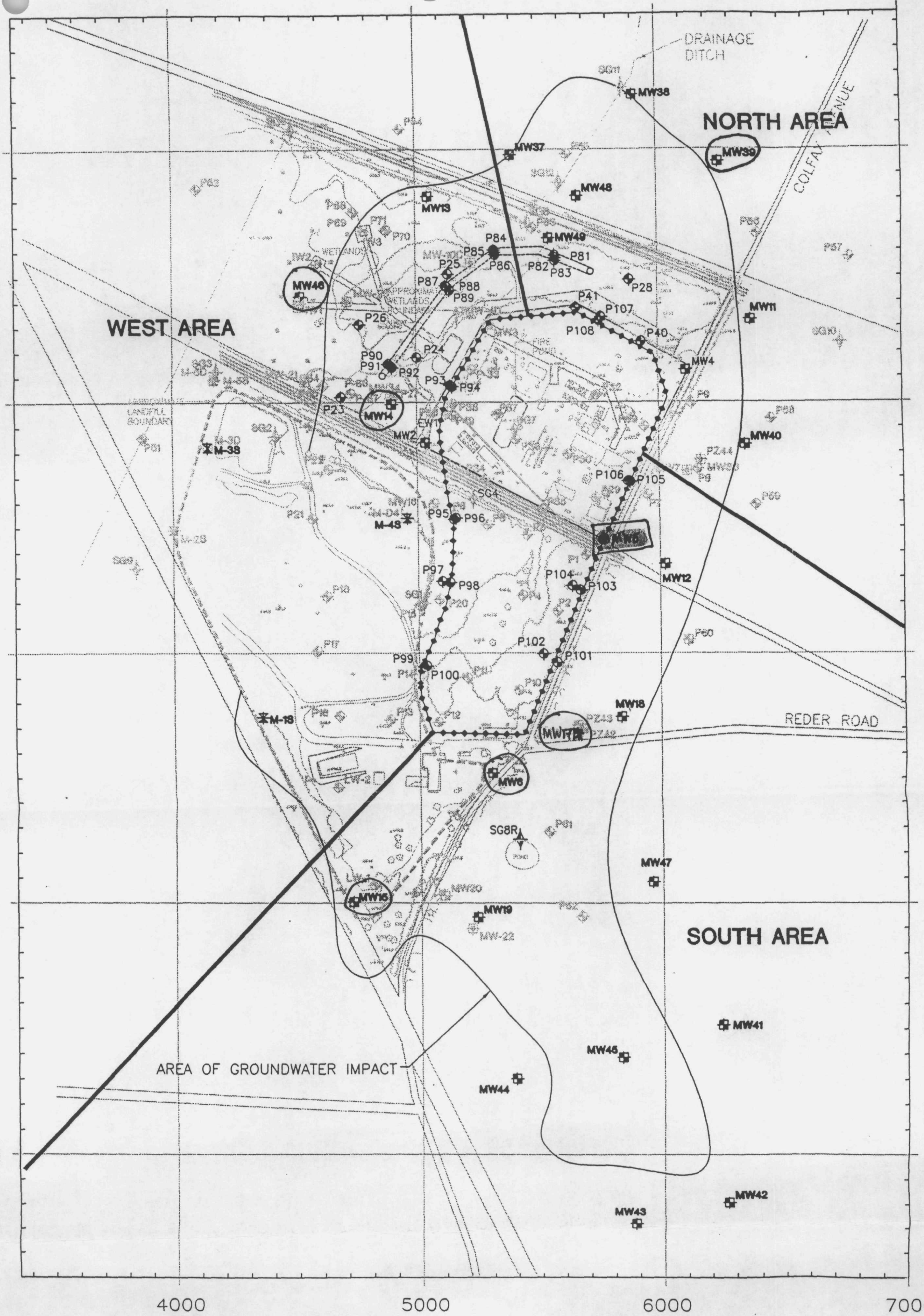

Figure B.9 - Locations of Vinyl Chloride Detections in the Upper Aquifer

□ - Concentration above 10 μg/L

O - Concentration below 10 μg/L

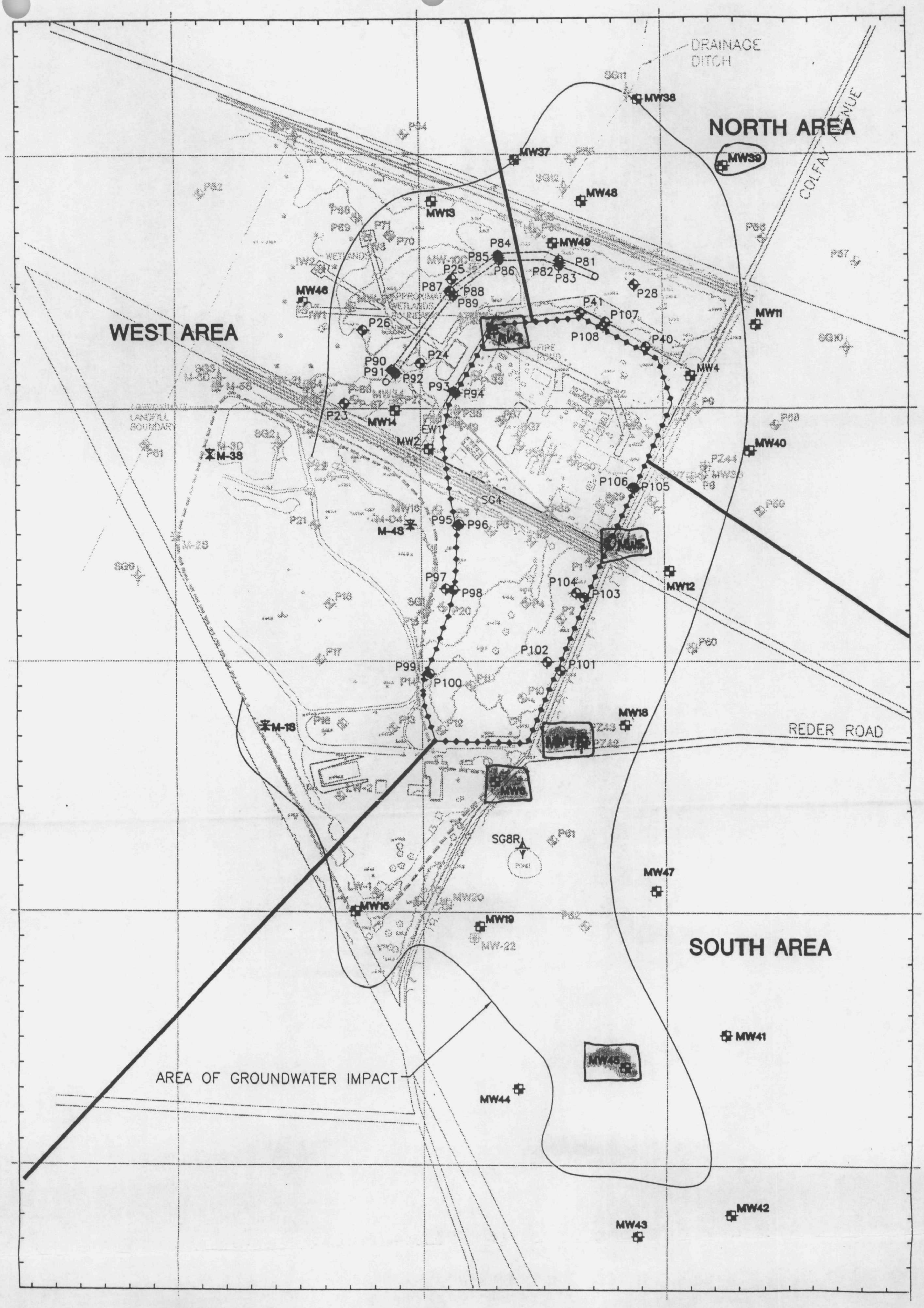

Figure B.10 - Locations of Xylenes Detections in the Upper Aquifer

□ - Concentration above 10 μg/L

O - Concentration below 10 μg/L

C

Long-Term Groundwater Monitoring Plan
Upper Aquifer Wells Monitoring Schedule
American Chemical Service NPL Site

Monitoring Location ID	Area of Groundwater Contamination	Location with	2002						2003				2004						2005						2006			
			1st Qtr				3rd Qtr		1st Qtr		3rd Qtr		1st Qtr				3rd Qtr		1st Qtr				3rd Qtr		1st Qtr		3rd Qtr	
			Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	Full Scan	Water Level	VOCs	Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	VOCs	Water Level	Full Scan
Monitoring Wells																												
MW11	North	Upgradient	X	X			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW12		Upgradient	X	X			X		X	X	X		X	X			X		X	X			X		X		X	X
MW13		Interior	X				X		X		X		X				X		X				X		X		X	
MW37		Downgradient	X	X			X		X	X	X		X	X			X		X	X			X		X		X	X
MW38		Transgradient	X				X		X		X		X				X		X				X		X		X	
MW39		Transgradient	X	X			X		X	X	X		X	X			X		X	X			X		X		X	X
MW40		Upgradient	X				X		X		X		X				X		X				X		X		X	
MW48		Interior	X	X			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW49		Interior	X	X			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW14	West	Downgradient	X	X			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW46		Downgradient	X				X		X		X		X				X		X				X		X		X	
MW06	South	Interior	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW15		Downgradient	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X
MW17		Upgradient	X	X			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW19		Interior	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X
MW41		Downgradient	X				X		X		X		X				X		X				X		X		X	
MW42		Downgradient	X	X			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW43		Downgradient	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X
MW44		Downgradient	X	X			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW45		Interior	X	X			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW47		Transgradient	X				X		X		X		X				X		X				X		X		X	
M4S		Griffith Landfill	X				X		X		X		X				X		X				X		X		X	
Staff Gauges & Piezometers																												
P13	South	Griffith Landfill	X				X		X		X		X				X		X				X		X		X	
P17	South	Griffith Landfill	X				X		X		X		X				X		X				X		X		X	
SG5	North	Interior	X				X		X		X		X				X		X				X		X		X	
SG8R	South	Downgradient	X				X		X		X		X				X		X				X		X		X	
SG13*	West	Wetland Pond	X				X		X		X		X				X		X				X		X		X	
SG14*	South	Runoff Pond	X				X		X		X		X				X		X				X		X		X	
PGCS Piezometer Sets																												
P82	North	center of PGCS trench	X				X		X		X		X				X		X				X		X		X	
P85	North	center of PGCS trench	X				X		X		X		X				X		X				X		X		X	
P88	North	center of PGCS trench	X				X		X		X		X				X		X				X		X		X	
P91	North	center of PGCS trench	X				X		X		X		X				X		X				X		X		X	
BWES Water Level and Piezometer Pairs																												
P31	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P32	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P36	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P93*	ONCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P94*	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P95	OFCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P96	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	

Ta'

Long-Term Groundwater Monitoring Plan
Upper Aquifer Wells Monitoring Schedule
American Chemical Service NPL Site

Monitoring Location ID	Area of Groundwater Contamination	Location with	2002						2003				2004						2005						2006			
			1st Qtr				3rd Qtr		1st Qtr		3rd Qtr		1st Qtr				3rd Qtr		1st Qtr				3rd Qtr		1st Qtr		3rd Qtr	
			Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	Full Scan	Water Level	VOCs	Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	VOCs	Water Level	Full Scan
P105	ONCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P106	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P107	ONCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P108	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P109	OFCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P110	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P111	OFCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P112	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
ORCPZ102	South	Griffith Landfill	X				X		X		X		X				X		X				X		X		X	
P113	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P114	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P115	OFCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P116	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P117	OFCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P118	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	

Notes:
VOC = Sample will be analyzed for Volatile Organic Compounds
SVOC = Sample will be analyzed for Semi-Volatile Organic Compounds
Arsenic = Sample will be analyzed for Arsenic
Full Scan = Sample will be analyzed for VOCs, SVOCs, Pesticides, PCBs, Metals, and Cyanide
BWES = Barrier Wall Extraction System
PGCS = Perimeter Groundwater Containment System
OFCA = Off-Site Containment Area
ONCA = On-Site Containment Area
* = P93 and P94 will be replaced during the On Site ISVE well installation.

Tab[illegible]
Long-Term Groundwater Monitoring Plan
Lower Aquifer Wells Monitoring Schedule
American Chemical Service NPL Site

Well ID	Well Screen Depth in Lower Aquifer	Location with Respect to Area of Groundwater Contamination	2002					2003				2004					2005					2006			
			1st Qtr			3rd Qtr		1st Qtr		3rd Qtr		1st Qtr			3rd Qtr		1st Qtr			3rd Qtr		1st Qtr		3rd Qtr	
			Water Level	VOCs	SVOCs	Water Level	VOCs	Water Level	Full Scan	Water Level	VOCs	Water Level	VOCs	SVOCs	Water Level	VOCs	Water Level	VOCs	SVOCs	Water Level	VOCs	Water Level	VOCs	Water Level	Full Scan
MW28	Upper	Upgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW50	Upper	Upgradient	X			X		X		X		X			X		X			X		X		X	
MW07	Upper	Upgradient	X			X		X		X		X			X		X			X		X		X	
MW10C	Upper	Interior	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW09R	Upper	Interior	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW29	Middle	Interior		X			X		X		X		X			X		X			X		X		X
MW23	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW24	Upper	Downgradient	X			X		X		X		X			X		X			X		X		X	
MW52	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW53	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW51	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW30	Middle	Downgradient		X			X		X		X		X			X		X			X		X		X
MW33	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW08	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW31	Middle	Downgradient		X			X		X		X		X			X		X			X		X		X
MW32	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW54R	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW55	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW56	Upper	Interior		X			X		X		X		X			X		X			X		X		X
M4D	Upper	Griffith Landfill	X			X		X		X		X			X		X			X		X		X	

Notes:

CAS/cas/PJV
J:/209/0603 ACS/ LTMP/Table 8,10.xls[LAPLan]

2

MWH
MONTGOMERY WATSON HARZA

March 6, 2002

Kevin Adler
Remedial Project Manager
U.S. Environmental Protection Agency
Region V, SR-6J
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Re: Response to U.S. EPA and IDEM Comments Regarding
The MWH December 27, 2001 Response to Comments on
The Draft Revised Long-Term GroundwaterMonitoring Plan,
American Chemical Service, Inc. NPL Site, Griffith, Indiana

Dear Mr. Adler:

Montgomery Watson Harza (MWH) has received additional comments from both the United States Environmental Protection Agency (U.S. EPA) and the Indiana Department of Environmental Management (IDEM) on the Draft Revised Long-Term Groundwater Monitoring Plan (the Plan) for the American Chemical Service, Inc. (ACS) NPL Site in Griffith, Indiana. As you are aware, the Plan was submitted in September 2001. We received the initial U.S. EPA and IDEM comments on the Plan in November 2001. After our site meeting on November 29, 2001, MWH responded to those comments in a December 27, 2001 letter. The second round of comments regarding our response letter was received February 5, 2002. We have included both sets of comments below in bold face type and followed each comment with a response and description of proposed action.

RESPONSE TO U.S. EPA COMMENTS

1. **Response to Comment 14. The inferred extent of impacted groundwater is smaller in the Draft Revised Long-Term Groundwater Monitoring Plan (RLTGMP) (see Figure 3) than in the Response to Comments on Draft RLTGMP provided by Montgomery Watson Harza (MWH) dated December 27, 2001 (see Appendix B of Response to Comments on Draft RLTGMP). What is the appropriate extent of impacted groundwater? Which figure is being included in the RLTGMP? MWH should be consistent with the delineated area of groundwater impact.**

27755 Diehl Road
Suite 300
Warrenville, Illinois
60555

Tel: 630 836 8900
Fax: 630 836 8959

The figure used in Appendix B of the December 27 letter was from the 1997 Groundwater Monitoring Plan, and the inferred extent of groundwater contamination was based upon the upper aquifer investigation completed in 1996. This figure was not intended to demonstrate the current extent of contamination or concentrations through time, but rather that benzene and chloroethane have always defined the extent of the plume, and thus are the compounds of concern. The dates and concentrations of each well were eliminated in order to simplify the figure. The inferred extent of impacted groundwater on Figure 3 of the RLTGMP was a revision of the historical extent. Based on the past few years of groundwater results, concentrations of VOCs have been at or below detection limits in samples from monitoring wells MW12, MW13, MW14, MW15, MW17, MW18, MW37, and MW38. All of these wells were inside of the groundwater plume or on its edge based on the 1996 study. In each future groundwater monitoring report, MWH will clarify any indication of inferred extent of impacts as based on historical results or recent results.

2. **Response to Comment 24. It was agreed that MW17 will serve as an upgradient well; however, based on the documentation dated December 27, 2001, MW17 is located within the area of groundwater impact (see Comment 1). In addition, MW17 has had detections of 1,2-*dichloroethene* (1,2-DCE), ethylbenzene, and xylene at concentrations greater than 10 ug/L (see Appendix B of Response to Comments on Draft RLTGMP). The date(s) and actual concentrations were not provided. Is MW17 a true upgradient well? Redevelopment of MW17 may be necessary in order to serve as an upgradient well. If MW17 is really in the area of groundwater impact then a new well in the vicinity of MW18 should be installed to be truly upgradient.**

The historical results of 1,2-DCE, ethylbenzene, and xylene at monitoring well MW17 are provided in the table below:

MW17

Date	1,2-DCE	Ethylbenzene	Xylene	Vinyl Chloride
May 1990	130	80	47	ND
Dec 1994	9	2	ND	2
June 2001	ND	NA	NA	ND

Notes:
All concentrations in micrograms per liter (ug/L)
ND = Not detected
NA = Not analyzed
Monitoring well MW17 was not sampled between 1994 and 2001

Monitoring well MW17, while now upgradient of contamination, is close to an area of elevated VOC concentrations in the groundwater (the intersection of Reder and Colfax Streets). Prior to the installation of the barrier wall in 1997, groundwater flow was south and east from the Kapica-Pazmey area. According to the upper aquifer investigation in

1996 (see response to Comment #1), the plume reached as far eastward as MW18. After the barrier wall was installed, VOC concentrations upgradient of the site (i.e., monitoring wells MW11, MW12, MW17, and MW18) have decreased. In addition to preventing the further migration from the Site, the barrier wall has also altered the groundwater flow direction near MW17. This change in flow direction, together with the sampling results tabulated above show that the plume has decreased in easterly extent since the completion of the Barrier Wall. If the plume should expand in this area in the future, the MW17 sampling point is well situated to provide the data. MWH will redevelop MW17 prior to the March 2002 sampling event.

3. **Response to Comment 64. MWH reports that elevated concentrations of bis(2-chloroethyl) ether are found at MW06, MW19, and MW09R, and has proposed annual sampling for this compound at these wells. MWH states that bis(2-chloroethyl)ether has "also been detected historically at MW14, MW46, MW48, MW49 and MW45; however recent detections of this compound at these wells have been below 3 ug/L." MWH does not provide a definition of "recent." Should these additional sampling locations be included?**

The table below provides the specific detections of bis(2-chloroethyl)ether in the five wells listed above.

Bis(2-chloroethyl)ether

Date	MW14	MW45	MW46	MW48	MW49
May 1990	ND	NA	NA	NA	NA
July 1990	ND	NA	NA	NA	NA
Jan. 1995	20	NA	NA	NA	NA
August 1996	NA	7 J	3 J	ND	ND
Nov 1996	12	NA	NA	NA	NA
March 1997	ND	13.5	2 J	10	2 J
June 1997	ND	8 J	4 J	18	ND
Sept. 1997	ND	13 J	5 J	ND	16.5
Dec. 1997	ND	ND	3 J	ND	ND
June 1998	ND	7 J	4 J	13	6 J
June 1999	ND	4 J	ND	18	ND
March 2000	4 J	ND	3 J	3 J	1 J

Notes:
All concentrations in micrograms per liter (ug/L)
J = Estimated concentration below the reporting limit
ND = Not detected
NA = Not analyzed (wells MW-45 to MW49 weren't installed until 1996)

From this tabulation, it is apparent that while the compound is occasionally detected at these wells, it is not a representative component in samples from these wells. For that reason, it was not proposed in the standard suite of parameters for routine sampling.

Of course, these wells will be tested for SVOCs twice in each five-year review period and so the designation of "not representative" can be revisited at these times. MWH does not believe it is necessary to include the analyses in these extra wells in the interim.

4. **Table 8. Staff Gauges SG13 and SG14 were not included in the Draft RLTGMP. Are these new staff gauges? If so, have their locations been placed onto Figure 1 in the Final RLTGMP?**

   SG13 and SG14 are proposed for installation in the wetlands pond and the detention pond in the Off Site Area. Their exact locations have not been determined yet, but Figure 1 in the Plan has been updated with their anticipated location.

5. **Table 8. Staff Gauges SG13 and SG14 are marked with an asterisk that refers to P93 and P94. Please update the footnote and symbol to reflect the appropriate information.**

   The footnotes on Table 8 have been corrected.

6. **Table 8. BWES Piezometers P3, P5, and P11 were included in the Draft RLTGMP; however, these piezometers were not included in MWH's Response to Comments on Draft RLTGMP. Were these piezometers damaged during the Off-Site cover construction? If so, were they replaced? If so, what is their identification numbers?**

   These three piezometers were destroyed during the construction of the Off-Site Area cap. MWH does not plan to replace them, as water levels inside the barrier wall are now measured weekly at several ISVE wells, which are more relevant with regard to the overall effects of dewatering pumping.

7. **Table 8. BVSPC assumes that piezometers P109 through P119 are the replacement piezometers for P97 through P104 installed by Boart Longyear in September 2001.**

   All tables in the Plan have been updated to indicate that piezometers P109 through P118 have replaced the destroyed piezometers P97 through P104.

8. **Table 10. The footnote for "Notes:" is blank. This should either be removed or the appropriate footnotes should be included.**

   The footnotes in Table 10 have been included.

RESPONSE TO IDEM COMMENTS

9. **Comment #22. According to IDEM staff notes of the November 29 meeting, it was agreed that MW13, MW37, and MW39 would be added and that they would be sampled semi-annually not annually. This may be a typo. However, IDEM staff recommend that MW13 be included in the semi-annual sampling events.**

   According to MWH notes, monitoring wells MW12, MW37, and MW39 were to added to the monitoring network, and sampled on an annual basis. It is our recollection from the meeting that monitoring well MW13 was not included however it can be added for annual sampling, to be revisited in the next monitoring plan revision.

10. **After reviewing the response to comments, IDEM staff recommend that a new baseline be created. The current baseline was developed with groundwater data that was generated before the barrier wall and groundwater extraction system were installed. IDEM staff recommend that Montgomery Watson Harza (MWH) use existing groundwater data to develop new baseline concentrations for the site. Using groundwater data collected after the barrier wall was installed, may make rebaselining the site easier and more cost effective. This approach is similar to what Black and Veatch recommended, but would provide a more accurate baseline.**

    Several concepts about the baseline were discussed during the meeting on November 29, 2001. However, our notes show that the consensus was to continue with the existing baseline for the time-being and thereby avoid potential complexities that a new baseline might introduce. For example, a significant number of the objectives listed at the beginning of the plan include evaluating the effectiveness of the remedial activities. To re-set the baseline would seemingly dismiss the history that is needed to make that evaluation.

    Since the make-up of the baseline is not related to the sampling parameters and locations, we recommend proceeding with the Plan, as modified in these responses to comments. As Kevin Adler observed at the meeting on November 29th, the monitoring plan is a "living document." We agree that it is appropriate to modify both the objectives and the requirements of the plan on occasion to insure that it is adequate for monitoring the Site and remains cost-effective. Therefore, we would be pleased to evaluate and discuss any specific recommendations you have for developing a new baseline.

If you have any further comments or questions, please do not hesitate to call me at (630) 836-8923.

Sincerely,

MONTGOMERY WATSON HARZA

Peter Vagt, Ph.D., CPG
Vice President

cc: Sean Grady, IDEM
Barbara Magel
ACS RD/RA Technical Committee

Attachments: Figure 1, Tables 7, 8 and 10

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2090603.030401

Table 7
Evaluation of Upper Aquifer Groundwater Monitoring Wells
American Chemical Service NPL Site, Griffith, Indiana

Well Identification	Area of Groundwater Contamination	Location with Respect to Area of Groundwater Contamination	OBJ #3 Upgradient	OBJ #4 Downgradient	OBJ #5 Interior
MW11	North	Upgradient	X		
MW12		Upgradient	X		
MW13		Interior			X
MW37		Downgradient		X	
MW38		Transgradient			
MW39		Transgradient		X	
MW40		Upgradient			
MW48		Interior			X
MW49		Interior			X
MW14	West	Downgradient		X	
MW46		Downgradient			
M-1S		Griffith Landfill			
M-4S		Griffith Landfill			
MW06	South	Interior			X
MW15		Downgradient		X	
MW17		Upgradient	X		
MW19		Interior			X
MW41		Downgradient			
MW42		Downgradient		X	
MW43		Downgradient		X	
MW44		Downgradient		X	
MW45		Interior			X
MW47		Transgradient			

Notes:

OBJ #3 = Objective 3: Collect and analyze groundwater samples from upgradient monitoring wells in the upper and lower aquifers to document background groundwater water quality.

OBJ #4 = Objective 4: Collect and analyze groundwater samples from the monitoring wells at the downgradient boundaries of the site to monitor the boundaries of groundwater impacts.

OBJ #5 = Objective 5: Collect and analyze groundwater samples from the interior of the areas of contaminated groundwater to assess progress toward attaining cleanup objectives in these areas.

Shaded wells = groundwater samples from well not needed to meet Objectives 3, 4, or 5.

Tab

Long-Term Groundwater Monitoring Plan

Upper Aquifer Wells Monitoring Schedule

American Chemical Service NPL Site

Monitoring Location ID	Area of Groundwater Contamination	Location with	2002						2003				2004						2005						2006			
			1st Qtr				3rd Qtr		1st Qtr		3rd Qtr		1st Qtr				3rd Qtr		1st Qtr				3rd Qtr		1st Qtr		3rd Qtr	
			Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	Full Scan	Water Level	VOCs	Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	VOCs	Water Level	Full Scan
Monitoring Wells																												
MW11	North	Upgradient	X	**X**			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW12		Upgradient	X	**X**			X		X	X	X		X	X			X		X	X			X		X		X	X
MW13		Interior	X	**X**			X		X	X	X		X	X			X		X	X			X		X		X	X
MW37		Downgradient	X	**X**			X		X	X	X		X	X			X		X	X			X		X		X	X
MW38		Transgradient	X				X		X		X		X				X		X				X		X		X	
MW39		Transgradient	X	**X**			X		X	X	X		X	X			X		X	X			X		X		X	X
MW40		Upgradient	X				X		X		X		X				X		X				X		X		X	
MW48		Interior	X	**X**			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW49		Interior	X	**X**			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW14	West	Downgradient	X	**X**			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW46		Downgradient	X				X		X		X		X				X		X				X		X		X	
MW06	South	Interior	X	**X**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW15		Downgradient	X	**X**		X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X
MW17		Upgradient	X	**X**			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW19		Interior	X	**X**	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X
MW41		Downgradient	X				X		X		X		X				X		X				X		X		X	
MW42		Downgradient	X	**X**			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW43		Downgradient	X	**X**		X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X
MW44		Downgradient	X	**X**			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW45		Interior	X	**X**			X	X	X	X	X	X	X	X			X	X	X	X			X	X	X	X	X	X
MW47		Transgradient	X				X		X		X		X				X		X				X		X		X	
M4S		Griffith Landfill	X				X		X		X		X				X		X				X		X		X	
Staff Gauges & Piezometers																												
P13	South	Griffith Landfill	X				X		X		X		X				X		X				X		X		X	
P17	South	Griffith Landfill	X				X		X		X		X				X		X				X		X		X	
SG5	North	Interior	X				X		X		X		X				X		X				X		X		X	
SG8R	South	Downgradient	X				X		X		X		X				X		X				X		X		X	
SG13[1]	West	Wetland Pond	X				X		X		X		X				X		X				X		X		X	
SG14[1]	South	Runoff Pond	X				X		X		X		X				X		X				X		X		X	
PGCS Piezometer Sets																												
P82	North	center of PGCS trench	X				X		X		X		X				X		X				X		X		X	
P85	North	center of PGCS trench	X				X		X		X		X				X		X				X		X		X	
P88	North	center of PGCS trench	X				X		X		X		X				X		X				X		X		X	
P91	North	center of PGCS trench	X				X		X		X		X				X		X				X		X		X	
BWES Water Level and Piezometer Pairs																												
P31	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P32	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P36	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P93[2]	ONCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P94[2]	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P95	OFCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P96	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	

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Long-Term Groundwater Monitoring Plan
Upper Aquifer Wells Monitoring Schedule
American Chemical Service NPL Site

Monitoring Location ID	Area of Groundwater Contamination	Location with	2002						2003				2004						2005						2006			
			1st Qtr				3rd Qtr		1st Qtr		3rd Qtr		1st Qtr				3rd Qtr		1st Qtr				3rd Qtr		1st Qtr		3rd Qtr	
			Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	Full Scan	Water Level	VOCs	Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	VOCs	SVOCs	Arsenic	Water Level	VOCs	Water Level	VOCs	Water Level	Full Scan
P105	ONCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P106	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P107	ONCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P108	ONCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P109	OFCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P110	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P111	OFCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P112	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
ORCPZ102	South	Griffith Landfill	X				X		X		X		X				X		X				X		X		X	
P113	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P114	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P115	OFCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P116	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P117	OFCA	Outside Barrier Wall	X				X		X		X		X				X		X				X		X		X	
P118	OFCA	Inside Barrier Wall	X				X		X		X		X				X		X				X		X		X	

Notes:

VOC = Sample will be analyzed for Volatile Organic Compounds

SVOC = Sample will be analyzed for Semi-Volatile Organic Compounds

Arsenic = Sample will be analyzed for Arsenic

Full Scan = Sample will be analyzed for VOCs, SVOCs, Pesticides, PCBs, Metals, and Cyanide

BWES = Barrier Wall Extraction System

PGCS = Perimeter Groundwater Containment System

OFCA = Off-Site Containment Area

ONCA = On-Site Containment Area

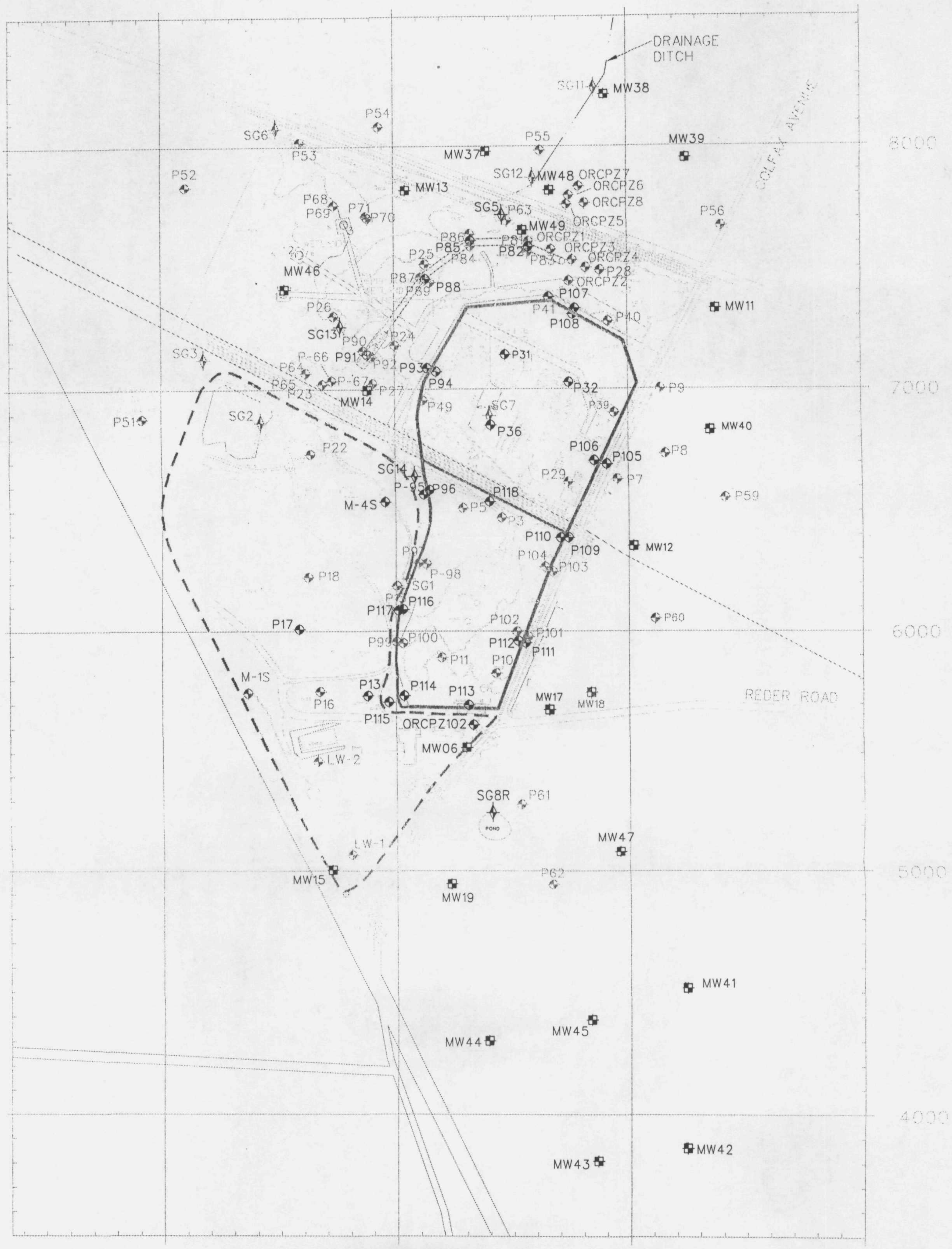
1 = Staff gauges will be placed in the wetlands pond and the detention pond in the Off-Site Area.

2 = P93 and P94 will be replaced during the On Site ISVE well installation.

Tabl[illegible]
Long-Term Groundwater Monitoring Plan
Lower Aquifer Wells Monitoring Schedule
American Chemical Service NPL Site

Well ID	Well Screen Depth in Lower Aquifer	Location with Respect to Area of Groundwater Contamination	2002					2003				2004					2005					2006			
			1st Qtr			3rd Qtr		1st Qtr		3rd Qtr		1st Qtr			3rd Qtr		1st Qtr			3rd Qtr		1st Qtr		3rd Qtr	
			Water Level	VOCs	SVOCs	Water Level	VOCs	Water Level	Full Scan	Water Level	VOCs	Water Level	VOCs	SVOCs	Water Level	VOCs	Water Level	VOCs	SVOCs	Water Level	VOCs	Water Level	VOCs	Water Level	Full Scan
MW28	Upper	Upgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW50	Upper	Upgradient	X			X		X		X		X			X		X			X		X		X	
MW07	Upper	Upgradient	X			X		X		X		X			X		X			X		X		X	
MW10C	Upper	Interior	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW09R	Upper	Interior	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW29	Middle	Interior		X			X		X		X		X			X		X			X		X		X
MW23	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW24	Upper	Downgradient	X			X		X		X		X			X		X			X		X		X	
MW52	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW53	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW51	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW30	Middle	Downgradient		X			X		X		X		X			X		X			X		X		X
MW33	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW08	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW31	Middle	Downgradient		X			X		X		X		X			X		X			X		X		X
MW32	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW54R	Upper	Downgradient	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
MW55	Lower	Downgradient		X			X		X		X		X			X		X			X		X		X
MW56	Upper	Interior		X			X		X		X		X			X		X			X		X		X
M4D	Upper	Griffith Landfill	X			X		X		X		X			X		X			X		X		X	

Notes:
VOC = Sample will be analyzed for Volatile Organic Compounds
SVOC = Sample will be analyzed for Semi-Volatile Organic Compounds
Full Scan = Sample will be analyzed for VOCs, SVOCs, Pesticides, PCBs, Metals, and Cyanide



LEGEND

BARRIER WALL

PERIMETER GROUND WATER CONTAINMENT SYSTEM

UPPER AQUIFER WELL LOCATION AND DESIGNATION

P61 PIEZOMETER LOCATION AND DESIGNATION

STAFF GAUGE LOCATION AND DESIGNATION

O3 SURFACE DISCHARGE LOCATION FOR PERIMETER GROUND WATER CONTAINMENT SYSTEM

ORCPZ1 ORC PIEZOMETER LOCATION AND DESIGNATION

NOTES:

1. GRAY WELLS INDICATE MEASUREMENT LOCATIONS INCLUDED IN 1998 GROUND WATER MONITORING PLAN.
2. P93 AND P94 DO NOT EXIST, BUT WILL BE REPLACED DURING 2002.
3. SG13 AND SG14 ARE PLANNED FOR INSTALLATION DURING 2002.

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SCALE IN FEET

REV	DATE	BY	DESCRIPTION

DESIGNED	CAS	DATE	4/26/2001
CHECKED		DATE	
APPROVED	PJV	DATE	

SCALE: AS SHOWN

MWH
MONTGOMERY WATSON HARZA

AMERICAN CHEMICAL SERVICES, INC.
NPL SITE
GRIFFITH, INDIANA

LONG-TERM GROUNDWATER MONITORING PLAN UPPER AQUIFER WATER TABLE MEASURMENT LOCATIONS

FIGURE 1

JOB No. 2090603 FILE: J:/209/0603 acs/drawings/LTMP/ua_wla.dgn

3

VIA EMAIL
March 12, 2002

Kevin Adler, SR-J6
Remedial Project Manager
U.S. Environmental Protection Agency, Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Re: Response to U.S. EPA Comments, emailed March 11, 2002
Regarding the MWH March 6, 2002 Response to Comments on
The Draft Revised Long-Term Groundwater Monitoring Plan,
American Chemical Service, Inc. NPL Site, Griffith, Indiana

Dear Mr. Adler:

Montgomery Watson Harza (MWH) received the following additional comments on the Draft Revised Long-Term Groundwater Monitoring Plan (the Plan) for the American Chemical Service, Inc. (ACS) NPL Site in Griffith, Indiana. These comments, received by email on March 11, 2002, were in response to MWH's March 6, 2002 letter. We have included the new comments in bold face type below, followed by a response and description of proposed action.

We believe that there is consensus at this time as to the locations and parameters for the sampling event that is scheduled for next week and so we are proceeding with plans to mobilize for the sampling on March 18th. In the meantime, if you have further comments or responses please provide them and we will address them as we continue to plan for the sampling. We will provide a paper copy of this letter along with previous response letters with the final draft of the Monitoring Plan when you indicate we have satisfactorily addressed the agency comments.

RESPONSE TO U.S. EPA COMMENTS

1. **Response to Item 2, MWH's Response to Comment 24 - MWH performed limited sampling of MW17 over the past 10 years (three sampling dates - 1990, 1994, 2001). BVSPC agrees with MWH's statement that since the barrier wall was installed, VOC concentrations upgradient to the site have decreased. The future sampling results for MW17 should be closely watched, keeping in mind that MW17 was once interior to the plume, in order to verify that the plume no longer extends to this area and that MW17 is truly an upgradient well.**

   MWH agrees with this observation, and will monitor the results from MW17 to verify that it is a valid upgradient / side gradient well for the monitoring network.

2. **Response to Item 10, MWH's Response to IDEM's Comment Regarding Baseline - BVSPC appreciates the issues of creating a new baseline and keeping the old baseline. It may be appropriate to create a "new" baseline (from existing data) now that the barrier wall system is in place and MWH will be recommending a corrective action to address the current groundwater contamination. There is some worth to maintaining the "old" baseline as a comparison to pre-remedial activities.**

As indicated in the previous response to comments, MWH agrees that there are benefits to modifying the baseline as long as there is not a result loss of historical understanding. We will be happy to discuss options for setting and naming a new baseline. In the meantime, MWH could add a visual marker to the Concentration vs. Time plots to point out the dates in which certain corrective actions were completed. For example, the markers could be added to indicate the dates that the following were completed: the barrier wall, the perimeter groundwater containment system, and the ORC applications. These could provide a 'quick' look at how these actions have affected the concentrations of benzene and chloroethane in groundwater without developing an entire new baseline.

At this time, when reviewing data from each monitoring event, MWH does watch for any sharp increase in concentrations as well as watching for baseline exceedances.

3. **Comment to Table 7 - MW13 (added per IDEM's request) is listed as interior to the plume and fulfilling Objective #5. According to Figure 3 in the Draft Revised Long-Term Groundwater Monitoring Plan (RLTGMP), dated September 2001, MW13 is exterior to the plume, located downgradient, and would therefore fulfill Objective #4.**

For simplicity, the designations for upgradient, downgradient, and inside the plume, were kept from the 1997 Groundwater Monitoring Plan. MWH believes it is important to remember that certain wells (such as MW13) were once inside the plume, and that a small detection in such a well may not indicate a change in the plume dimensions. MWH can modify the description for MW13 to "downgradient" or add a footnote to the table indicating that it was an interior well at an earlier time.

4. **Comments to Table 8 - Correct third column heading to read "Location with Respect to Area of Groundwater Contamination." The location for MW13 should be corrected to read downgradient instead of interior. The column headings for "SVOCs" should be changed to "bis(2-chloroethyl)ether" to reflect the annual analysis of MW06 and MW19 for this compound only, not the full suite of SVOCs.**

The changes have been made to the table.

5. **Comment to Table 10 - The column headings for "SVOCs" should be changed to**

"bis(2-chloroethyl)ether" to reflect the annual analysis of MW09R for this compound only, not the full suite of SVOCs.

The changes have been made to the table.

6. **BVSPC assumes that the remaining figures, tables, and text have been updated correctly based on MWH's letter Response to Comments on Draft Revised Long-Term Groundwater Monitoring Plan dated December 27, 2001.**

   All figures and tables have been updated to reflect the groundwater monitoring activities outlined in Tables 8 and 10, which were included in MWH's March 6, 2002 letter.

If you have any further comments or questions, please do not hesitate to call me at (630) 836-8923.

Sincerely,

MONTGOMERY WATSON HARZA

Peter Vagt, Ph.D., CPG
Vice President

cc: Sean Grady, IDEM
Barbara Magel
ACS RD/RA Technical Committee

CAS/PJV
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, ILLINOIS 60604

June 26, 2002

Mr. Peter Vagt
Montgomery Watson Harza
27755 Diehl Road - Suite 300
Warrenville, IL 60555

Re: Long Term Groundwater Monitoring Plan
ACS, Inc. Site, Griffith, IN

Dear Mr. Vagt:

U.S. EPA, in consultation with the state, has reviewed the December 2001 Long Term Groundwater Monitoring Plan (LTGMP) written by MWH. Based on our discussions concerning the last few comments, the LTGMP is in approvable form. Please send me 2 copies of the final document for our files (and provide one to B&VSPC if possible).

Please call me at (312) 886-7078 if you have any questions.

Sincerely,

ka.

Kevin Adler
ACS Project Manager